POWER

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STEP BY STEP

• WHO CAN CHART AMERICA'S COURSE for the next ten years—or five? Who can chart his own business? Who can say which products will catch the popular fancy of that day? Who can say which business groups will forge ahead or which will drop behind? Nobody can.

• BUSINESS MEN of ten years back had no clearer vision. They only thought they had, as today's events prove. But now, as in the past, it is possible to plan progress without foreseeing the exact course of that progress. Step-by-step modernization is one method.

• IT WORKS THIS WAY: A certain factory, say, starts from scratch with an antiquated power plant. Obsolete, hand-fired, low-pressure boilers. Wasteful auxiliaries. No instruments. Old engines blowing exhaust steam to atmosphere all summer long. Fuel and labor dollars leaking at spigot and bunghole.

• THE WHOLE PLANT calls aloud for modernization, but the owner hesitates, fears to make such a large investment all at once. He is not quite sure of the business trend or the ultimate future of his product. Yet he knows that inaction is even more dangerous—makes loss certain.

• STEP-BY-STEP MODERNIZATION meets his situation. He avoids heavy plunging, makes first the small, quick-paying investments. Each step pays for the next. At each stage the owner is financially ahead, and at each he is free to adjust his layout to new trends without scrapping the investment already made.

• THE FIRST MODERNIZATION STEP in the case cited is instruments; they cost little, yield a high return immediately, fit any future power set-up. Next, perhaps, several of the small boilers are replaced by a single modern unit, built for higher pressure, but temporarily operated at the old. Its greater efficiency and better design start an immediate saving in coal, labor and maintenance.

• FINALLY COME MODERN GENERATING UNITS and the replacement of the remaining boilers. Plant pressure goes up. Steam waste goes down. More dollars are saved.

• THIS IS JUST A SAMPLE. Each case will differ in general plan and in specific steps. The point is that no plant can afford to delay modernization simply because a complete job may not be practicable at once. Do something now, even if it is no more than the installation of a feed-water meter.

What Price Coal?

● Nobody knows how much, but coal-prices are going up—and in a hurry. The Washington dog-fight of rival coal interests ends with a code for the industry signed by President Roosevelt and now in operation. The code increases labor costs and will necessarily raise prices.

Power men took little part in the code arguments, but they cannot avoid sharing the result. They face rising steam costs. All methods and equipment that increase unit evaporation and cut steam consumption are worth just that much more; they will pay out in fatter coin.

Not only that; the general rise will not be uniform, because the code affects some coal fields more than others. Result: a complete shuffle of relative fuel dollar values—a literal "new deal," forcing every coal buyer to play a new game of coal selection.

The Heat Dollar

● Winter is in the offing with a handful of bigger and better bills for heating and ventilating the factory, hospital, office building and public building. Here is a great field for the Scotchman and those willing to copy his virtues without freezing the tenants.

Check your system now—traps, valves, lines, controls, vacuum pumps. Leaks and uneven heat are prime sources of waste. Both can be controlled.

Buzzard Point

● This year sees the completion of just one large steam-electric central station—the low record of many decades. Fortunately this record is not likely to be duplicated because utility loads are now rapidly overhauling the existing capacity.

The Buzzard Point station of the Potomac Electric Power Company, which *Power* is privileged to describe and explain in this issue, is of extreme interest in many ways. Consider the boiler, for example. Only 5,488 sq.ft. of evaporating surface (549 horsepower!) in a single-pass bank, five tubes high, generates 375,000 lb. of steam per hour. The superheater has as much surface, the economizer twice as much, and the air heater eight times as much. The double superheater, with deheater, maintains a constant steam temperature of 835 deg.

Christmas is Coming

● NRA spreads employment for machines as well as men. A factory cuts hours from 45 to 40 say, and takes on new hands. They are needed to get out more work per hour. This, in turn, demands more steam per hour—also more electricity, refrigeration, hot water, etc. The weekly power-service output may or may not increase, but the hourly must.

That means higher loads and fewer unemployed power units. New machines must be put to work, first those idle in the plant and, soon after, those now in the shops or on the drafting boards of equipment manufacturers. And the new machines, like the new hands, must be "hired" on a rising market. Their wages—the fixed charges—are going up. "Shop early for Christmas."

Electric Drive Plus Mechanical

● Much human energy is wasted in attempting to prove that mechanical drive is better than electric drive, or the reverse. Why fight nature? Why not recognize the simple facts, which are these:

1—There is no indication whatever that the one type of drive will or can generally replace the other.

2—Each has a certain field where it will flourish unalloyed, because best adapted to conditions.

3—More important still is the great field of overlap, where mechanical transmission and electric drive work best in double harness.

Power adds the following statement to the record: "In the majority of cases it is more economical to do a power application job by a combination of electrical and mechanical means than by either alone."

POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

BUZZARD POINT
—THE YEAR'S NEW CENTRAL STATION

By MAURICE W. CARTY
Mechanical Engineer
Stone & Webster, Inc.

THE maximum peak load of the Potomac Electric Power Company's system is expected to reach about 145,000 kw. this year. Benning Power Station includes both 25-cycle and 60-cycle equipment, and about 130,000 kw. is of moderately high pressure and economical in constant service. During this year, a high-tension transmission line (230,000 volts) has been put into service, bringing into Washington power from the Safe Harbor and other stations of the Consolidated Gas, Electric Light & Power Company's system. This line will supply firm peak service.

Study of the complete power system and analysis of the probable future requirements indicated that a new power plant, on a site at a distance from the present Benning station, would be a desirable development. Basic design of the power station should be suitable for a future capacity of about 250,000 kw.

A satisfactory site was finally purchased at Buzzard Point, having frontage on the Anacostia River near its junction with the Potomac. Deep water is close to the shore, railroad connections have been provided and the property is in the center of what is planned to be a port and industrial development. An important advantage of the Buzzard Point site is that the tie-in to the distribution system can be made underground at generating voltage, consequently without resort to step-up and step-down transfer substations.

Favorable costs for equipment and materials were assured, as well as satisfactory supply and rates for labor, so it was decided to proceed this year with the initial step in the power plant at Buzzard Point. The Stone & Webster Engineering Corporation was awarded the contract to design and construct the new station, that corporation having worked in close cooperation with the engineers and executives of the Potomac Electric Power Company for many years in the development of power supply in Washington.

A 35,000-kw. turbine-generating unit was selected for the initial development, and will be placed in operation during the autumn of the present year. It is expected that the next future unit will be of the same capacity. The turbine will have 18 stages and will operate at 1,800 r.p.m. Generating voltage will be 13,800 and a direct-connected exciter and pilot exciter are on the main shaft extension. A 3,600-r.p.m. unit was considered, but it was decided to adhere to the lower speed and well tried out design in this capacity. It was concluded that there would be no steam extraction for commercial service outside the station's own requirements and that 3-stage bleeding would be provided for boiler feed-water heating.

Hydrogen gas was considered for generator cooling, but the simpler air circulating system was adopted. The turbine exhausts to a single-pass condenser with two compartment water boxes and with two circulating water pumps. The water boxes are horizontally divided and can be quickly drained in case the turbine goes non-condensing.

A steam pressure of 650 lb. was selected, and the total steam temperature was limited to 825 deg. at the turbine throttle. In the present stage of the metallurgical art, this temperature is about as high as metals commercially available can be depended on for reliable service with allowable rates of creep. A simple regenerative cycle without reheating of steam is consistent with these pressure and temperature conditions. A station heat rate of about 12,200 B.t.u. per kw.-hr. net output is expected at full load, which is the point of maximum heat efficiency.

A problem of great importance was involved in the selection of the method of burning coal, which will prob-

FEATURES

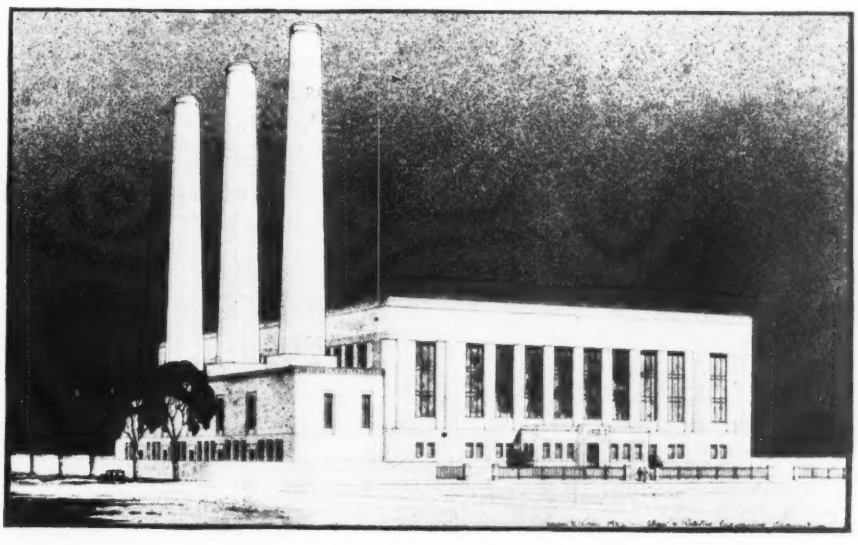
Fireproof room under turbine for lubrication oil supply and pressure pipes run inside welded return drain lines to avoid hazard of oil fires.

Very high-head, single-pass boiler; divided superheater; economizer within boiler casing; light-weight insulating fire brick, chromium-oxide painted, used as lining for upper wall casings.

Steam deheater with bypass valve to control superheated steam exit temperature.

Electrostatic precipitators three sections deep, with uniform distribution of gas flow in and out.

Automatic withdrawal and conditioning of fly ash for auto truck disposal.



ably come from West Virginia. Obviously in Washington, which is distinctly a residential city with many large white marble and limestone public buildings, elimination of fly-ash discharge from the stacks is vitally important, and the appearance of smoke would be quite objectionable. After detailed study of comparative investments for a stoker-fired plant and for a pulverized-fuel burning plant, also after analysis of operating results and especially as regards cleanliness of stack discharge, a pulverized-fuel burning plant was selected as definitely the best for the plant. Comparisons were made on the basis of a stoker plant to operate with moderate rates of combustion per square foot of grate area and fully equipped with mechanical cinder-eliminating devices. Similarly, the pulverized-fuel burning plant was considered with not excessive rates of combustion per cubic foot of furnace volume and fully equipped with electrostatic fly-ash precipitators.

From the operating point of view, the pulverized-fuel burning plant is the more desirable because of its flexibility in the use of a wide range of coals, the utilization of high-temperature preheated air for combustion, the adaptability for automatic control, ability to follow changes in load and the ease of operation at low ratings. The furnaces are well adapted to burn oil or gas, although the probability of utilizing these fuels seems to be remote. In the desirable size of steam-generating units for this plant, requiring about 375,000 lb. per hour evaporation, the pulverized-fuel installation is advantageous in so far as general arrangement, adherence to unit layout principle, compactness and low building height are concerned.

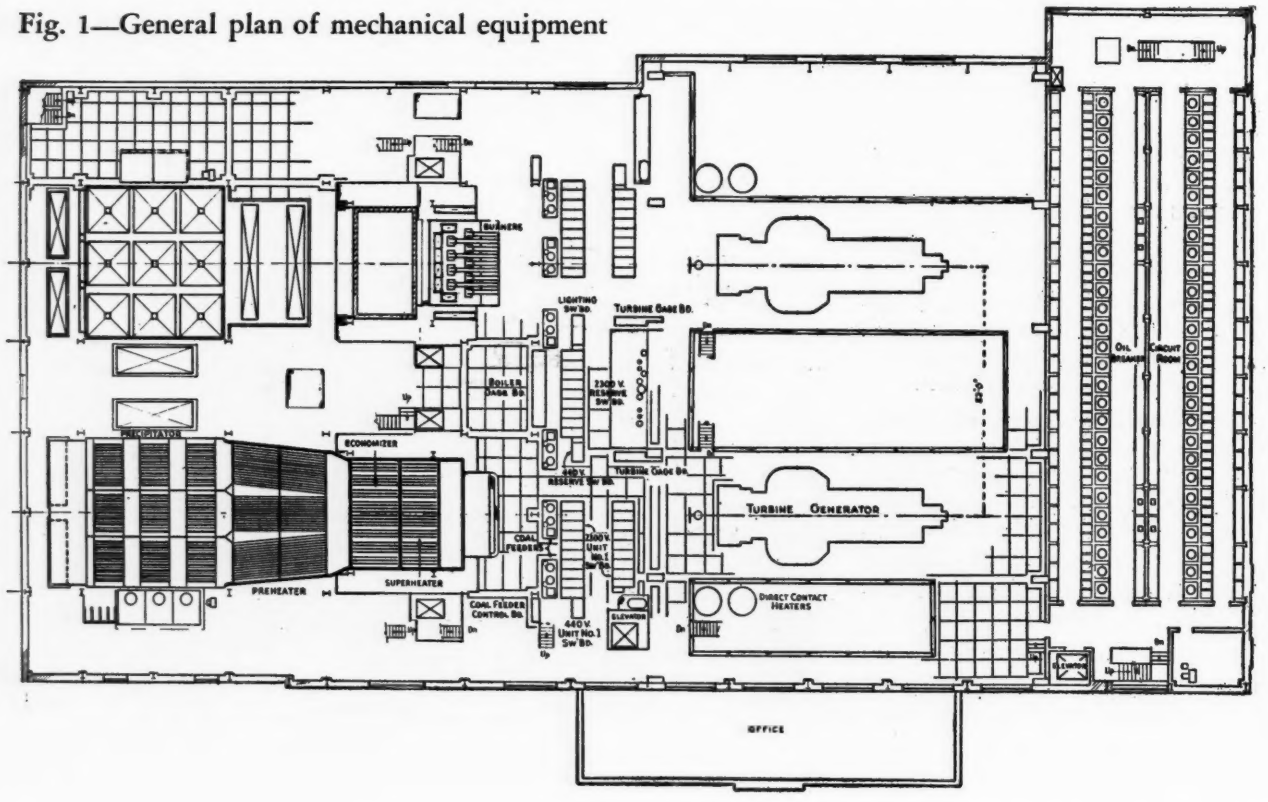
In view of the fly-ash hazard, it was decided at the outset that a boiler design must be developed which would be single pass and without baffles where soot and cinders would accumulate. A high-head type, single cross-drum, straight-tube boiler unit was selected. The superheater and economizer divisions of the unit are separated by a vertical, water-cooled, central baffle. A sloping section of the baffle directs the exit gases evenly into the air preheater. Staggered furnace slag-screen tubes, refractory covered, are provided across the throat of the furnace. Above this the walls are lined with bare cast-iron blocks as a cooling zone up to the entrance to the boiler tubes. The boiler is 33 tubes wide, only five tubes high, with a tube length of 20 ft. Evaporation per header section will be 6,000 lb. per hour, assuming 50 per cent of the total steam is made in the furnace water-wall tubes at full load. The five rows of boiler tubes result in sufficient reduction in gas temperatures so that low-carbon steel tubes suffice in the superheater.

The superheater is located on the gas up-flow side of the vertical baffle. Steam velocity in the superheater tubes is high, and, as an added precaution to avoid evcessive tube-wall temperature, parallel flow is adopted so that the tubes carrying saturated steam come in contact with the hottest gas. The superheater is divided into two parts, a primary section and a secondary section. Steam, after passing through the lower or primary section, is diverted into an external deheater and then returned into the secondary or upper section of the superheater.

The deheater consists of a vertical nest of hairpin tubes immersed in water from the boiler drum, with a straight-through passage at the base in which is a butterfly valve. The butterfly valve governs the amount of steam passing through the cooling tubes, and is automatically controlled from the temperature of the steam leaving the secondary section of the superheater. Steam made in the water space of the deheater passes to the boiler drum. Working steam pressure in the boiler drum will be about 730 lb. gage, and the steam temperature at the superheater outlet will be 835 deg. F.

A multiple-loop economizer is located on the gas down-flowing side of the vertical baffle and entirely within the casing of the boiler unit, making a compact

Fig. 1—General plan of mechanical equipment



arrangement and one resulting in minimum radiation loss and low infiltration of air. The water inlet is at the lower end, to obtain a counter-flow effect in heat transference.

Above the boiler tubes the casing walls are constructed of removable steel-plate panels lined with lightweight insulating fire brick, coated with chromium-oxide paint to resist abrasive action of the ash particles in the flue gas. Ledge deflectors are provided at the lowest and highest tubes of the superheater and economizer to impede the flow of gas against the walls.

The furnace is entirely water cooled, and all water walls except the arch below the furnace slag screen are refractory covered, using Bailey stud-tube construction and plastic refractory mix. Arch tubes are covered with Bailey refractory blocks, and smooth cast-iron blocks are used on the furnace bottom tubes.

A slag-tap type furnace was decided upon in order to retain the maximum amount of ash in the furnace and to facilitate the handling of this ash as disintegrated slag in a wet sluicing system, with discharge by pumps into an elevated storage bunker.

Multiple intertube pulverized-coal burners are downwardly inclined to increase the ash deposited in the furnace bottom, and to insure quick and complete combustion, with consequent avoidance of smoke. It is expected that at least 40 per cent of the ash in the coal will be retained in the furnace. A single slag spout is provided in the back of the furnace in a central location at a point of high temperature.

The furnace volume up to the lowest boiler tube is 12,050 cu.ft., and the heat liberation will be about 40,000 B.t.u. per cu.ft. per hr. at full capacity. The boiler drum is large, being 72 in. in diameter, and the drum extends 7 ft. on each side beyond the line of the tube deck to build up ample water storage, so avoiding marked fluctuation in level with change of load.

Steam from the boiler is washed in the drum by the incoming feed water before it passes to the superheater. It is expected that the steam delivered from the boiler to the superheater will not contain over 0.25 per cent of moisture at full load and that carry-over of solids to superheater will not exceed one part in a million by weight.

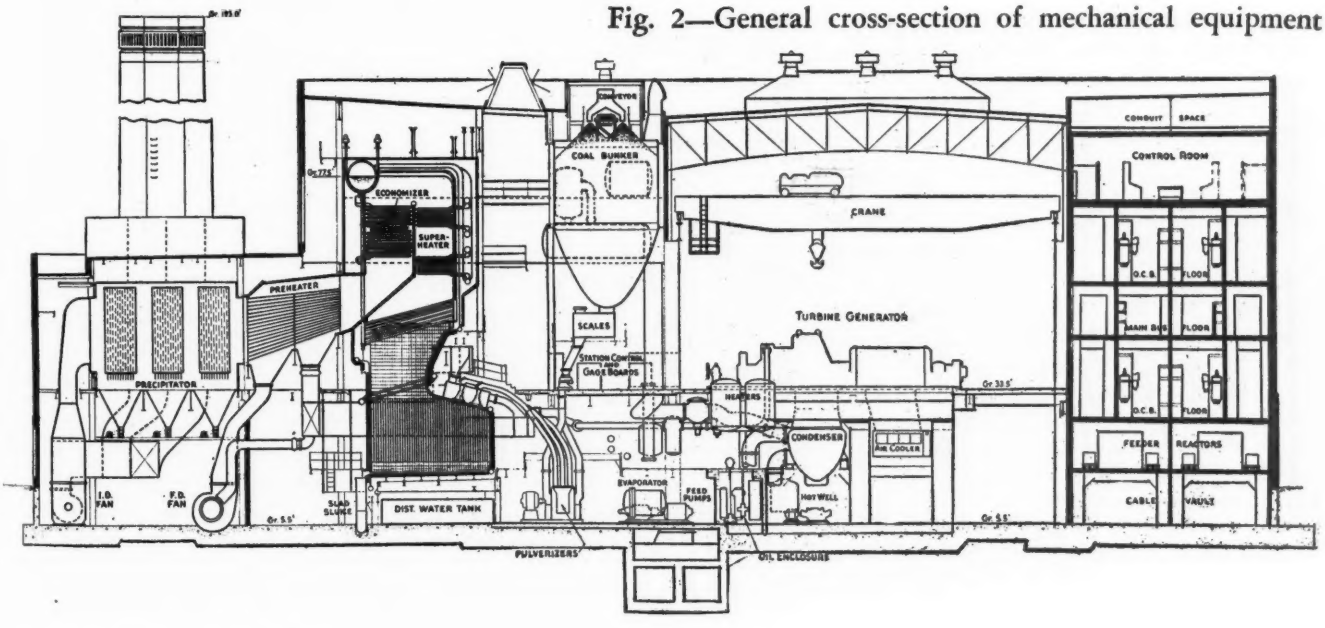
There are three pulverizer units per boiler furnace (one omitted initially for each boiler) each supplying three burners. It is expected the boilers can be operated as low as 15 per cent of full steaming capacity with three burners in operation, although, of course, increased load must be carried prior to tapping slag.

The furnace design is planned so that the sweep of the flames will cause a considerable portion of the ash of the coal to stick to the pool of molten slag on the furnace bottom. The burners are 14 ft. above the bottom, and this moderate distance is desirable to facilitate bringing up temperature of the slag prior to tapping. The furnace slag-screen tubes are spaced sufficiently far apart so that there can be no choking from bridging of slag, and their refractory covering is hot enough to be sticky, so that the molten ash particles run down and drip off at the lower ends.

An air preheater was desired of a type without soot pockets, which would insure uniform distribution of gas entering the fly-ash eliminators in a horizontal direction. The tubular type with gas flow through the tubes was selected as being the most suitable for this installation. A vertical traveling-type soot blower was developed for cleaning the preheater tubes. Control of metal temperature in the preheater is provided by recirculation of varying amounts of the heated air from the forced-draft air ducts. This keeps the tubes dry so that they do not plug up with soot, and their life is prolonged. The preheater is two-pass in its air circulation, and the temperature of outgoing air is about 425 deg. F. at full load.

A study of all types of dust catchers, including observations in actual operation with pulverized fuel, resulted in the selection of the Cottrell electrostatic precipitator as the most effective and easiest to maintain in service. It was decided, however, in view of the importance of fly-ash elimination in Washington, to install the precipitators three sections deep in the direction of gas flow instead of only two, which is the more common practice. The efficiency of removal of the ash particles will be about 96 per cent at full capacity and on the average better than this. Assuming that 40 per cent of the ash in the coal will be retained in the furnace, and 96 per cent of the remainder caught, an over-all elimination is indicated of better than 97 per cent at full load. The Cottrell precipitator installation

Fig. 2—General cross-section of mechanical equipment



has been planned for best results, with the gases entering uniformly distributed and in horizontal flow, and leaving the units in liberally proportioned exit ducts connecting to the induced-draft fans. Consequently, the efficiency in elimination is high, as it is mainly dependent on moderate gas velocity in each of the many paths of flow through the Cottrell units.

Disposal of the fly ash when caught is often a problem. It was decided for this station to provide automatic draw-off from the Cottrell hoppers and disposal by vacuum air transport system to Durite metal cyclone separators above an elevated steel-plate unlined storage bin. In this way the fly ash is handled perfectly dry. Draw-off from the storage bin is through a star feeder and then through a rotary dustless unloader in which there is an admixture of a controlled amount of water, so that the conditioned ash is discharged into auto trucks and can be transported to a distance without difficulty or escape of the material.

The general plan of the station is shown by Fig. 1. This shows the "unit principle" arrangement—that is, one boiler with its separate group of pulverizers and fans, and the corresponding turbine-generating unit with its condenser and auxiliaries. The boilers face the turbines. Estimated steam requirement of the turbine and its auxiliaries is about 325,000 lb. per hr. Corresponding boiler capacity provided is about 15 per cent higher. This is for the purpose of gradually building up surplus steam-producing capacity as the station develops, roughly equivalent to the capacity of one of the initial boilers. The crosswise arrangement of the turbines best matches up with the width of the boiler units in the capacities planned in this station. The width of the turbine room is ample for a 50,000-kw. unit, and the corresponding boiler unit can be provided in the same column spacing as for the first two boilers.

Direct firing was decided upon—that is, without bin storage of pulverized fuel. This is a simpler and safer method than the bin system. Control is centralized in the aisle between the boilers and the turbines, where are located the boiler gage board, combustion control board and the turbine gage board. At a lower level are located the boiler-feed pump gage board, the condenser gage board, and the water make-up and auxiliary control board. There is no wall between the boiler room and the turbine room.

The cross-section of the station is shown by Fig. 2. The precipitators are at a fairly low level, which makes for economical construction because they are heavy, and also results in convenient operation. A controlling feature is a zone height limit of 90 ft. from the street level to the coping of the parapet wall.

The coal bins are completely sealed off from the main building. The flow of coal from the station bunker to the feeders, then to the pulverizers and finally to the burners is very direct. Coal-handling arrangements are simple, consisting of railroad track scale and hoppers and belt conveyors to the station and drag scraper equipment for stocking and recovering the coal. The layout results in a low unobtrusive solid storage pile and consequently in minimum blowing around of coal dust.

All the auxiliaries are motor operated except one of the lubricating oil pumps and the emergency steam-driven boiler-feed pump. Use of thyratron frequency conversion to obtain unidirectional current suitable to operate motors to run at varying speeds was considered. The conclusion was reached, however, not to adopt this

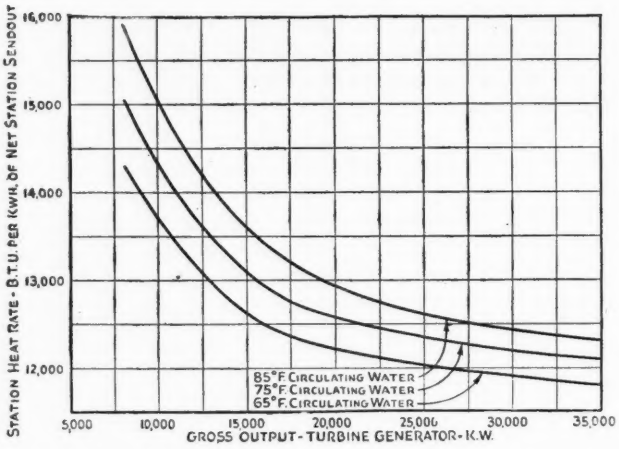


Fig. 3—Station heat rate of unit No. 1, with steam supplied to turbine-generator by one boiler

system at this time, but to adhere to more completely tried out equipment. The forced- and induced-draft fans are driven by constant-speed, squirrel-cage motors through hydraulic couplings. This gives the required control of speed with high efficiency through a wide range of operation. Each unit consists of a motor, hydraulic coupling, then a fan, a flexible coupling, the second fan, with space for a future hydraulic coupling and a future motor. Water cooling of the coupling oil is necessary. The initial motor will operate at 900 r.p.m., the future motor at the other end of the shaft at 1,200 r.p.m. Control of speed is obtained by the automatic adjustment of the weir level in oil tank supplying the hydraulic coupling.

This arrangement gives a smooth speed curve, quick response to varying demands, and low power consumption. Obviously, with the two forced-draft fans coupled together in operation at light loads, there is a more uniform distribution of air discharge to the preheater than would be the case with only one of two fans running. Similarly, there is a more uniform pull through the cross-section of the precipitators than would be obtained with only a single induced-draft fan in operation at higher speed. It is evident that the noise of operation is less on the average with both fans in service running at only moderate speeds than with single fans running at high speeds.

Open heaters were adopted for service in the regenerative heat cycle because of the higher efficiency and lower capital investment, as compared to closed heaters. These open heaters consist essentially of perforated trays with water flow as "rain" in direct contact with steam extracted from the turbine. The piping runs are short, and, in order to obtain a simple arrangement, the extraction lines come only from the 14th, 11th and 7th stages of the turbine. A desuperheating heater, however, is installed in the extraction line from the 7th-stage heater, which will elevate the final temperature of the feed water about 6 deg. F. above the saturation temperature of the steam bled from this stage.

To safeguard against explosion in the pulverizers, gas explosions in the boilers and faulty lighting of the coal burners, a complete interlock system is provided to assure the proper sequence in starting up and closing down equipment or in case of failure of any unit, also to throw over automatically to a second source of power in essential services, such as the coal feeders.

Special attention has been given to safeguard the station against oil fires. The turbine oil equipment is entirely enclosed in a fireproof room immediately under the turbine. The oil pump geared from the main shaft of the turbine is located there, also the oil coolers, strainers, oil reservoir, oil purifiers and the pump part of the relay oil unit. All pressure piping to the turbine hydraulic gear and bearings, also to the three non-return valves in the steam extraction lines, are run inside of drain lines returning to the oil reservoir. These lines are welded and without joints. Obviously any leakage in the pressure lines cannot spurt onto hot steam pipes or accumulate in a hazardous manner. This oil room and the main generator coils are protected with CO_2 gas bottles automatically discharged in case of fire. A separate fire-proof room is provided for oil storage, filtering and conditioning which is protected by steam smothering nozzles.

Flange covers in high-temperature lines are replaceable blankets of rock wool 4 in. thick, shaped to the curvature of the flange and made up in asbestos cloth with brass wire insertion. Inside this blanket is aluminum foil sheet to radiate heat back into the flanges and studs when the lines are being heated from a cold condition. This tends to prevent excessive stress in the studs.

The general plan of the initial development, assuming two turbine units, provides about 36,000 sq.ft. of ground area, including the electrical bay, or about 0.5 sq.ft. per kw. capacity. The building volume is about 3,000,000 cu.ft., or about 43 cu.ft. per kw. capacity.

EQUIPMENT DATA, BUZZARD POINT POWER PLANT

General

Location, Buzzard Point, Washington, D. C.
Initial capacity ..... 35,000 kw.
Ultimate capacity ..... 250,000 kw.
Designed and built by Stone & Webster Engineering Corporation.

Fuel Handling and Burning

Storage capacity 20,000 tons storage, distribution by drag power shovel, 5,000 lb. capacity Beaumont Birch Company
Belt conveyors, 30 in. wide, 150 tons per hr. Stephens-Adamson Mfg. Co.
Coal swing hammer mill, 150 tons per hr. Pennsylvania Crusher Co.
Fly-ash vacuum air transport and separating system ..... United Conveyor Corp.
Slag & ash storage tanks, each 3,000 cu.ft. Allen-Sherman-Hoff Co.
Slag sluice and pump ..... Allen-Sherman-Hoff Co.
Coal pulverizers, initially 2 per boiler, capacity 16,000 lb. per hr. each, 250-hp. motor, 885 r.p.m. Riley Stoker Corp.
Coal burners, initially 6 per boiler, 5,333 lb. per hr. capacity, multiple intertube downward-inclined firing ..... Babcock & Wilcox Co.
Forced-draft fans, 2 per boiler, initial capacity 50,000 c.f.m. each, 10.4 in. static pressure, horizontal double inlet, 2 fans on one shaft, 250-hp., constant-speed motor, 900-r.p.m., 30-in. hydraulic coupling ..... American Blower Corp.
Induced-draft fans, 2 per boiler, horizontal double inlet, initial capacity 84,000 c.f.m., each, 9.5 in. pressure, 2 fans on one shaft, 450-hp., 900-r.p.m., constant-speed motor, 36-in. hydraulic coupling ..... American Blower Corp.
Fly-ash precipitators, Cottrell, 3 units wide, 3 sections deep, Cottrell plates, 6 ft. 5 in. wide, 17 ft. 6 in. high, 2 in. thick with ⅜-in. rod embedded electrodes, 75,000 volts, to remove 97 per cent of suspended matter ..... Research Corp.
Chimney, radial brick, 15 ft. 9¼ in. dia. at top, 159 ft. 6 in. high ..... Rust Engineering Co.
Railroad track scales ..... Howe Scale Co.
Coal weigh scales ..... Richardson Scale Co.
Belt weightometer ..... Merrick Scale Mfg. Co.

Boilers and Auxiliaries

Boilers, two straight-tube, high-head, cross-drum, 72 in. dia., drum, vertical water-cooled baffle, single-pass, 730 lb. pressure, 5,488 sq.ft. heating surface, water walls, 12,050 cu.ft. furnace volume ..... Babcock & Wilcox Co.
Superheater multi-loop, convection, two-sections, 835 deg. F., 5,438 sq.ft. heating surface Babcock & Wilcox Co.
Deheater, between superheater sections, vertical tubes immersed in water, 1,250 sq.ft. surface, coal 375,000 lb. steam per hr. from 760 to 650 deg. F. ..... Babcock & Wilcox Co.
Economizer, inside boiler setting, multi-loop type 2½ in. tubes, 11,197 sq.ft. heating surface Babcock & Wilcox Co.
Air preheaters, 1 per boiler, horizontal tubular, gas flows through tubes, 2 pass air flow, 46,998 sq. ft. heating surface, 425 deg. final air temperature ..... Babcock & Wilcox Co.
Safety valves ..... Crosby Steam Gage & Valve Co.
Blow-off valves ..... Cochrane Corp.
Soot blowers ..... Diamond Power Specialty Corp.
Water columns ..... Diamond Power Specialty Corp.
Boiler feed-water regulators ..... Swartwout Company

Turbine and Auxiliaries

Turbine generator, 35,000-kw., 18-stage 1,800-r.p.m., steam rate 7.87 lb. per kw. hr. generator, 3-phase, 60-cycle, 13,800-volts, 0.9 p.f., direct-connected 140-kw. exciter with pilot exciter ..... General Electric Company
Condenser, horizontal, single pass, external air cooler, reheating hotwell, 30,000 sq.ft. surface, steam-jet air removal ..... Ingersoll-Rand Co.
Admiralty tubes rolled at both ends Phelps-Dodge Corp. and Scoville Mfg. Co.
Extraction heaters 3-open direct-contact rain type, receive steam from 14th, 11th and 7th stages, capacity 231,700 lb. water per hr. ..... Foster Wheeler Corp.
Desuperheating heater using 7th stage steam. Foster Wheeler Corp.
Evaporators. 2-high-pressure, single-effect 4,500 lb. each, steam from 7th stage ..... Foster Wheeler Corp.
Evaporator condenser, 1 vertical straight tube, closed-floating head, 2-pass., capacity 900 lb. per hr., 690 sq.ft. surface ..... Foster Wheeler Corp.
Evaporator deaerating feed water heater, 1-open tray type, 10,000 lb. per hr. capacity, zero oxygen ..... Elliott Co.
Oil coolers, 2-vertical, 300 g.p.m. 150 to 85 deg. F. ..... Schutte & Koerting Co.
Blow-down heat exchanger, coil type, continuous blow-down from boilers ..... Griscom-Russell Co.
Generator air coolers, 1,560 sq.ft. surface, 80,000 c.f.m., from 133 to 95.9 deg. F., 600 g.p.m. cooling water ..... General Electric Co.

Pumps

Boiler feed pumps, 2-motor driven, 700 hp., 1 Terry turbine drive, each 400,000 lb. per hr., 900 lb. pressure, 7-stage single-suction ..... Ingersoll-Rand Co.
Circulating water pumps, two 25,000-g.p.m., 288-r.p.m., 125-hp., 2,300-v., induction motor .. Ingersoll-Rand Co.
Condensate pumps, two, 750-g.p.m., 145-ft. discharge head, 1,150-r.p.m., 60-hp., 2,300-v. induction motor ..... Ingersoll-Rand Co.
Condensate booster pumps 2 duplex horizontal centrifugal units, each unit 400,000-lb. per hr. capacity, discharge pressure 212.4 lb., 1,800 r.p.m., 200-hp., 2,300 v., induction motor. FosterWheeler Corp.
River water, 2-3,500 g.p.m. Worthington Pump & Machinery Corp.
Cooling water, 1-2,000 g.p.m. Worthington Pump & Machinery Corp.
Distilled water 2-800 g.p.m. Worthington Pump & Machinery Corp.
Evaporator feed pump 2-25 g.p.m. Worthington Pump & Machinery Corp.
Ash spray 2-1,000 g.p.m. .. Worthington Pump & Machinery Corp.
Drain sump, 3-150 g.p.m. .. Worthington Pump & Machinery Corp.
Oil transfer pumps, 4 ..... Hayes Pump & Machinery Corp.

Tanks

River water storage 1-1650 gal. ..... Dowington Iron Works
Distilled water storage 2-19,800 gal. ..... Dowington Iron Works
Distilled water, cold surge 1-5,800 gal. ..... Dowington Iron Works
Distilled water, hot surge 1-4,300 gal. ..... Foster Wheeler Corp.
Blow-off tank ..... Dowington Iron Works

Instruments

Boiler meters—steam flow, air flow, feed water meters ..... Bailey Meter Co.
Indicating pressure gages ..... Star Brass Mfg. Co.
Conductivity and pyrometer recorders ..... Leeds & Northrup Co.
Load indicator ..... Chas. J. Henschel & Co., Inc.
Recording and dial type indicating thermometers ..... Foxboro Co.
Recording pressure gages ..... Foxboro Co.
Draft gages ..... Ellison Draft Gage Co.
Indicating glass stem thermometers Consolidated Ashcroft Hancock Co.
Smoke Density recorder ..... Bailey Meter Co.
Corrosion tester ..... Cloyd M. Chapman
Combustion control ..... Hagan Corp.

Pipe, Fittings & Valves

High-pressure steam
Corrugated pipe (carbon-molybdenum) ..... M. W. Kellogg Co.
Fittings (chrome-molybdenum) ..... Babcock & Wilcox Co.
Gate Valves (chrome-tungsten) ..... Chapman Valve Mfg. Co.
Boiler non-return ..... Wm. Powell Co.

Feed Water

Fittings (chrome-nickel) ..... Babcock & Wilcox Co.
Globe valves ..... Lunkenheimer Co.
Angle stop & check ..... Edward Valve & Mfg. Co.
Atmospheric relief ..... Atwood & Morrill Co.

Miscellaneous

Traveling screens ..... Link Belt Co.
Air compressor, 233-c.f.m. ..... Ingersoll-Rand Co.
Motor-driven exciter, 200-kw. ..... Allis-Chalmers Mfg. Co.
Turbine-room crane, 100-ton ..... Whiting Corp.
Turbine oil purifiers ..... Sharples Specialty Co.
H.P. drainage controllers ..... Stets Co.
Steelplate air ducts ..... Connery & Co., Inc.
Heat insulation ..... Philip Carey Co.

A PLAN FOR PUBLIC

THINKING on unemployment relief in the United States has gone through three successive stages. All three, of course, are based on the fundamental that people must not be allowed to starve.

The first stage was the support of the unemployed by charity.

The second was to give work to those in need by:

a. Public jobs designed to enhance the beauty or livability of the country.

b. Stimulation of private business.

Obviously the second plan is immensely superior to the first. This is recognized in the formation and vast activities of N.R.A. (National Recovery Administration) and P.W.A. (National Emergency Public Works Administration), both of which are set up under the N.I.R.A. (National Industrial Recovery Act).

Inherent in P.W.A., but recognized by few, is a third approach to the cure of unemployment, by the modernization of public buildings at no cost to anybody. This statement, blunt and brief, appears to be the negation of common sense, but it is not.

What is proposed is not a device, like that of the toll bridge, which shifts the cost from the building agency to the users. (This, of course, is no criticism of toll-bridge projects.) It is actually proposed that the benefits derived shall cost nothing either to private individuals, taxpayers, cities, states or to the country as a whole.

All engineers will immediately understand this possibility from their own experience in the modernization of industrial equipment. To make clear to others the nature of such work, let us consider an elementary example:

An Example

A public building, for example, a state capitol, is equipped with an antiquated heating system. Obsolete boilers and firing equipment waste fuel. Additional fuel is wasted through improper design, installation and control of the heating system. Wastes of steam through inoperative traps cause still further loss of coal. For lack of proper control equipment, some rooms are underheated, some overheated. The present coal bill is $10,000 per year.

A competent and disinterested engineer studies this building and finds the following: An expenditure of $20,000 to modernize the boilers, firing equipment and heating system, will cut the yearly fuel bill to $6,000 and insure much greater comfort than now exists.

Let us next assume that some agency advances the $20,000 on this basis, namely, that the $20,000 shall be returned in ten annual installments, plus 4 per cent interest on the unpaid balance. Principal payments will then be $2,000 per year. Interest will range from $800 the first year to zero the last, averaging about $400. The net cost to the owner (assumed to be the state) will approximate $2,400 per year, leaving him a clear saving of $1,600 per year for the first ten years. At the end of ten years, moreover, the building owner will own improvements, free of incumbrance, which have cost him $16,000 less than nothing. The agency advancing the money will have

been fully repaid, with interest, and much employment will have been created.

With all indebtedness automatically cleared up, the owner's yearly coal saving, after the ten-year period, will be "pure velvet."

Those who desire may correct the figures of this example for some other rate of interest and for a more scientific evaluation of the interest on deferred payments. The final situation, however, will remain substantially unchanged.

The foregoing, of course, is not intended to show the actual financial arrangements possible with the aid of the Public Works Administration. It merely serves to demonstrate the possibility of making public improvements and creating employment at zero cost. Elimination of fuel waste or other waste will pay for the entire job.

It is proper for engineers, who are naturally more familiar with such matters, to point out to business men, legislators and public officials that the example cited is not a mere curiosity, but rather is typical of existing possibilities in thousands of instances.

This principle is used constantly by progressive manufacturers to cut costs and increase dividends. They spend to save. In the present emergency the principle can be used with equal certainty to accelerate industrial recovery and improve employment. Where it requires public funds to finance, the tax payers will be repaid and with huge profits, without any ultimate cost to the users of the resulting improvements or to any other individuals or groups.

Practical Application

The heating system was chosen for an example, to make the idea clear. Its practical operation at the present time should extend to cover all the mechanical services in a great variety of public-use buildings and institutions owned by the Federal Government, state governments, municipalities or even by certain private groups (for example, hospitals).

The principal services considered, familar to all engineers, are:

Steam and power generation
Heating and ventilation
Water supply and plumbing
Refrigeration and air conditioning
Elevators
Sprinkler systems

The plan, originally proposed by a prominent New England manufacturer, is summarized on the facing page. This plan has already received the endorsement of many engineers and engineering groups. It is basic and makes no pretense at laying down the operating details.

Certain points call for amplification or re-emphasis. It is obvious, first, that without seeking aid of the national government, any individual business, state or city, may apply this principle to its own affairs. It may employ consulting engineers to survey buildings, particularly old buildings, to determine what savings are possible, what capital investment will be required, how soon the job can be started, how rapidly it can be completed, what approximate fraction of the total expenditure will go to create employment of primary and secondary labor, and of white-collar workers (engineers and draftsmen.) With a batch of such preliminary surveys in hand, it can select those that offer the largest savings, and then get to work.

Government aid is not essential to the application of this plan to individual projects. It is clear, however, that Federal assistance in the original financing would greatly increase the incentive under present conditions. Provision for such aid is now definitely a part of the law of the land. "N.I.R.A. itself, in Title 2, Sections 202 and 203," here we are quoting the leading editorial from September *Power*, "directs the President, through the Public Works Administrator, to prepare a program of public works, including the repair and improvement of public buildings. It permits him to finance such federal jobs from public funds. States and cities may be granted outright up to 30 per cent of the cost of material and labor for projects of this nature, plus a loan of the remaining cost of the job.

For an understanding of the details of procedure it is, of course, necessary to refer to the law itself, which not only defines the type of assistance that can be rendered, and its legal safeguards, but also specifies the labor and other requirements of jobs carried through with such assistance.

Those concerned should study Circulars 1 and 2 of the Public Works Administration and the forms which must be filled out by those who apply for loans and grants.

Pending the possible development of a national set-up for the necessary preliminary surveys, local engineering and business groups are, of course, entirely free to cooperate with state and city engineers in any mutually satisfactory manner to rush through preliminary surveys.

Next to the soundness of the projects, and their general adaptation to the social aims and legal requirements of N.I.R.A., the most important requirement is speed. Projects must be designed to create the most employment in the shortest possible time.

Of the $3,300,000,000 authorized for the Public Works Program, more than half has already been allocated to a great variety of federal, state and municipal projects. It is the announced intention of President Roosevelt and Secretary Ickes, Public Works Administrator, that the remaining $1,500,000,000 be assigned to specific jobs before the end of the year. Every week of

IMPROVEMENTS AT ZERO COST

delay in starting and completing preliminary surveys reduces by just that much the chances of federal aid.

Projects of the type under discussion are ideally suited to the present situation and the requirements of N.I.R.A. for the following reasons:

1. **Their cost is zero. Even the 30 per cent (of material and labor) outright grant to the state or municipality merely shifts a portion of the taxpayers' burden from state taxes to U. S. taxes. It does not represent any cost whatever to the nation as a whole, since state taxes will be reduced far more than this by the savings resulting from the improvements made. Neither, of course, does the remaining 70 per cent, financed locally or by loans.**
2. **A part of the yearly saving can actually be set aside to liquidate the government loan.**
3. **Another part can be set aside to liquidate the investment of the state or municipality.**
4. **The remainder is a direct saving in the operating budget of the state building, city building, school or other structure involved.**
5. **Immediate employment will be given to engineers in survey and layout.**
6. **With projects approved and contracts let, work can be started almost immediately on much of the job, particularly on piping, foundations, heating systems. Simultaneously, manufacturers can start work on major equipment not in stock and have it ready in a few weeks or months, for installation with new labor.**
7. **Much local labor will be employed in installation, particularly of piping and heating systems. The amount of this labor will be almost proportional to the population.**
8. **All materials purchased (the law uses the term "materials" to include equipment to be installed) also represents mainly labor in its cost. Thus, in a typical job of this sort, more than 80 per cent of the total cost will be labor.**
9. **The labor created will be in the two fields now most lagging—and for that reason the greatest worry of N.R.A.—capital goods and construction.**
10. **The improvements made, unlike the building of new factories, will not create new manufacturing productive facilities to compete with the ample capacity already in existence. Nor will it create a future burden of maintenance and upkeep.**
11. **Being indoors, the work can be carried on right through the winter, when highway construction and other outdoor public work will lag. This winter's unemployment is a definite challenge that must be met.**

From every social and financial angle the plan fits the Nation's needs in the present situation. *Power* therefore urges engineers everywhere to bring this matter to the attention of state and local authorities in order that action may be started immediately. Pending the development of definite suggestions for procedure by national engineering bodies, and possibly by the Federal Government, it is urged that each locality, on its own, and in its own way, arrange to *get surveys started.*

Speed Necessary

A fairly good plan, operating in two or three weeks, is better than a perfect plan delayed two or three months. By the time surveys of savings are complete, further steps in procedure should be clear. Local business men and public officials could be enlisted to study this problem while engineers are completing their surveys.

There is always the possibility of the state or city proceeding with the best projects under its own steam, in case Federal aid should be withheld or delayed. Taxpayers should prefer to invest their funds at a high rate of return (through reduced operating cost of tax-supported buildings) rather than sink money in the hole of unemployment relief funds this winter.

(*Power* is having several hundred reprints made of this article, together with the leading editorial of the September number. From one to five copies will be sent on request to any engineer, city or state government official or other interested person.)

THE PLAN IN OUTLINE

It is suggested that heating, power, plumbing, electrical and allied types of equipment in every existing public property be surveyed with a view to determining where modernization of such equipment will be self-liquidating within a reasonable time. Federal engineers, state engineers, city engineers and others who are responsible for such equipment are already aware of many places where economies can be effected by such modernization. Recommendations regarding many of these specific projects could, therefore, be made at once and others follow along at an early date. It is believed, however, that a survey of every property and a report regarding the efficiency of operation in the mechanical equipment with comparative results in one property as against other similar properties would reveal many more places where self-liquidating expenditures could be made than would otherwise be discovered.

It is suggested, therefore, that either an adequate force of engineers be placed at the disposal of the engineer now in charge of public properties or, in lieu of this, that the services of competent consulting engineers be employed to bring in such comprehensive reports.

Merely as a suggestion as to some of the items which might effect these economies, we list the following:

(a) Installation of central heating plants for groups of public buildings which are now heated by separate boiler plants.

(b) Zoned automatic control of heating system for large office buildings. This modern type of automatic control has shown savings of from 20 to 50 per cent in fuel bills in many large buildings.

(c) Installation of or elimination of power-generating equipment where estimated costs reflect favorably as against existing methods of generating electrical current or its purchase from a utility company.

(d) Modernization of piping with welded joints where present upkeep and maintenance is excessive.

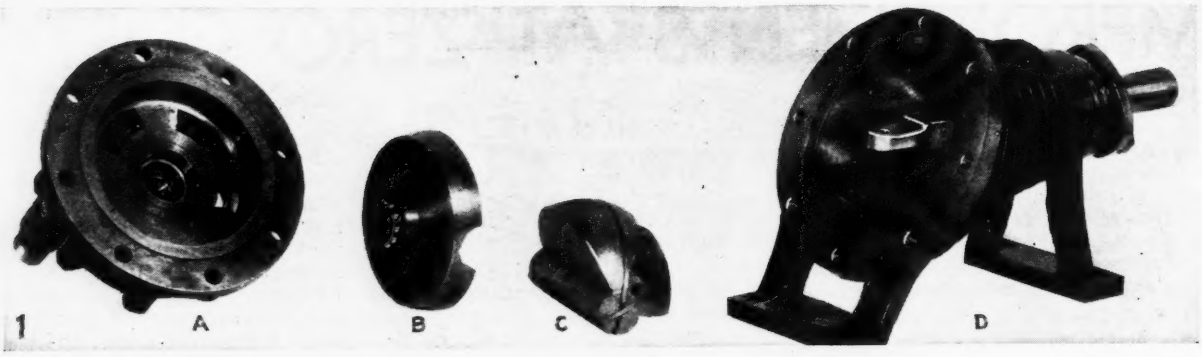
(e) Installation of modern unit heaters or air conditioners which lend themselves to automatic control and economy of operation as compared to some of the old types of pipe coils and other heating equipment now installed.

(f) Insulation of piping or modernization of existing insulation for fuel saving.

(g) Installation of modern boiler equipment, elevator machinery, compressors, etc.

It is believed, if those responsible for expenditure of public funds will carry on a comprehensive investigation along the general lines outlined above, they will establish these four facts:

1. *That considerable sums of money can be spent for mechanical equipment in a manner which will be quickly self-liquidating.*
2. *That the work of obtaining such comprehensive reports together with the engineering and supervision of such installations will provide much needed work for the so-called "white collar" engineering class of labor who by and large are probably more in need of immediate help than the average laboring man who works with his hands.*
3. *That work of this nature provides a great deal larger proportion of labor cost to total cost than does road building, reclamation projects, etc.*
4. *That such work does not add to productive capacity, but simply eliminates a present waste. Moreover, as weighed against new construction, it does not call for future fixed expense for maintenance, operation and depreciation.*



UNUSUAL DESIGN CHARACTERIZES

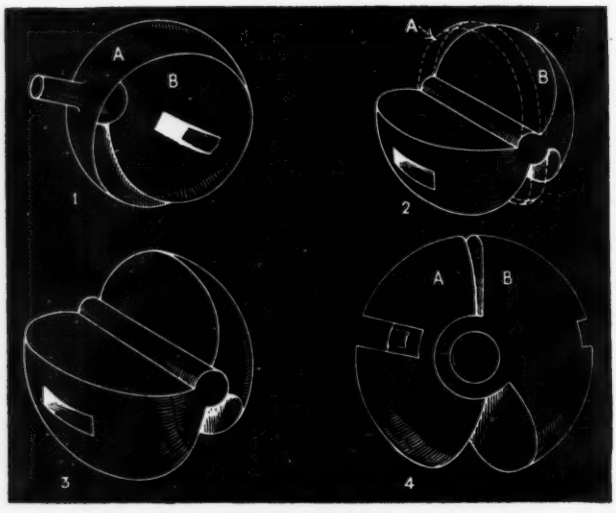
NEW ROTARY PUMP

AN ADAPTATION of the familiar wabble-plate pump, a new positive-displacement rotary here illustrated is of interest because of its number of possible adaptations and few moving parts. Patented by James L. Kempthorne, the unit is basically a spherical segment carried in a chamber having spherical surfaces and closed by an abutment with faces corresponding to the faces of the segment. As the segment rotates, it follows a wabbling path which causes its faces to approach and recede from the abutment. This causes compression and suction simultaneously, one occurring on each face of the piston or segment.

In Fig. 1, *C* is the segment, with one of its piston faces at left. The driving shaft is pinned into the slot at back. The cylinder at the center of the segment acts as a wearing surface and seal between the cylinders against the abutment *B*. Ports are in the head *A*, with discharge at top left, intake at lower right. The chamber is at *D*, with the end of the driving shaft visible.

The peculiar motion of the segment is more obvious in Fig. 3. At *A*, the segment is in the position which causes its upper half to correspond to top dead center in a piston pump, while the lower half is at a position corresponding to bottom dead center. *B* shows both at half stroke, one face working on compression, the other on intake.

Fig. 2—Possible adaptations of the rotary pump include: 1, variable capacity unit; 2, a 4-cyl. unit; 3, two-stage rotor; 4, double-capacity unit with twin lobes



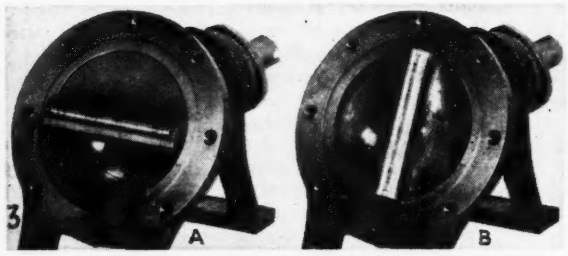


Fig. 3—The rotor at "full" and "half" stroke. At *A*, the upper lobe is at discharge position, lower at full intake; at *B* both are at midstroke

Several university laboratories have tested the unit and report it sound in principle and possessing such features as light weight, small bulk, almost complete absence of reciprocating motion (permitting elimination of a flywheel), positive displacement with small clearances, and in most cases elimination of valves. Some difficulty was found in earlier models at higher pressures due to friction of the segment against the rear face. This has been corrected by inserting a thrust bearing on the shaft and using semi-circular piston rings to seal.

As indications of some possible adaptations of the pump as compressor, liquid motor or possibly even as a gas engine, sketches of Fig. 2 may prove of interest. In 1 is shown a variable-capacity unit, abutment *A* being adjustable in the head to decrease capacity from maximum through zero to maximum in the opposite direction. In 2 is an adaptation for a 4-cyl. unit, the abutment becoming two half disks and the segment double lobed. This doubles capacity without increasing friction appreciably. This unit may have a through shaft if desired. In 3 is a two-stage pump or compressor, with lobes of different radius. If left-hand lobe edges are removed it might be used as a 2-cycle engine with spark plugs and other parts added. At 4 is the latest development, a double-capacity unit without an abutting plate. In this unit, intake and exhaust would be through side ports, and friction and thrust are both partially offset.

AN ENERGY PARADOX EXPLAINED

By ARTHUR EDWARDS

THERE are two general locations for a fan in connection with an air-heater, either ahead of the heater as shown at *A*, or after the heater as *B*. In either set-up, the ducts can be designed to give exactly the same friction loss, and equally efficient fans can be installed. With the same initial and final temperatures and pressures, and when handling the same amount of air, the result accomplished with either arrangement is obviously the same. Nevertheless, much less horsepower will be required to drive the fan if it is on the cold side of the heater than if on the hot side, as in Fig. 1 (b).

Why is this? I shall attempt a brief explanation of the paradox.

In the case illustrated by the diagrams, 100,000 c.f.m. of combustion air at 40 deg. F. is to be heated to 240 deg. F. and delivered under forced draft equal to a 6-in. water column. For purposes of discussion, the fan, duct and heater may be considered as hydraulically 100 per cent efficient, in order to eliminate the air temperature-rise due to energy dissipation by friction.

Now, if the perfect fan is placed ahead of the heater, as at *A*, it will handle air at room temperature and require a definite amount of driving power (about 94.5 hp.) to produce the required forced draft. If the perfect fan is placed as in *B*, it must handle the same weight of air at a higher temperature, which means a greater volume. Therefore, since the volume has expanded and the increase in pressure is the same, the fan will theoretically demand a considerably greater driving power (about 132 hp.).

What becomes of the additional energy supplied to the fan shaft in the second case? Regarding the preheater and fan as a unit, obviously nothing additional is accomplished.

Steam to the preheater is controlled by a thermostat. Is the steam consumption adjusted thereby, so as to offset the difference in fan energy input, and assure the same over-all result? If so, how can this be reconciled with the fact that the specific heat of air is the same at either pressure, and that the location of the fan appears to make no difference to the air preheater? In other words, how does the thermostat know on which side of the heater the fan is.

Explanation

The principle of conservation of energy is not refuted by this paradox of the fan and the air preheater.

Draft fans are usually considered as low-pressure paddle wheels that stir up a lot of frictional heat, and their theoretical power consumption is calculated as though there were no adiabatic temperature rise. Having assumed 100 per cent hydraulic efficiency, it is natural to overlook the possibility of any air temperature rise in the perfect fan. Nevertheless, this rise amounts to a couple of degrees even when friction is eliminated, and decreases slightly the duty required of the preheater. Furthermore, the temperature rise due to compression is greater when the fan is on the high-temperature side of the heater to the same extent that the power consumption is greater. This is immediately apparent if air compressors be substituted for fans in our mental conception of the work done in the two cases. The effect is to decrease the heating steam requirements even more in the second instance.

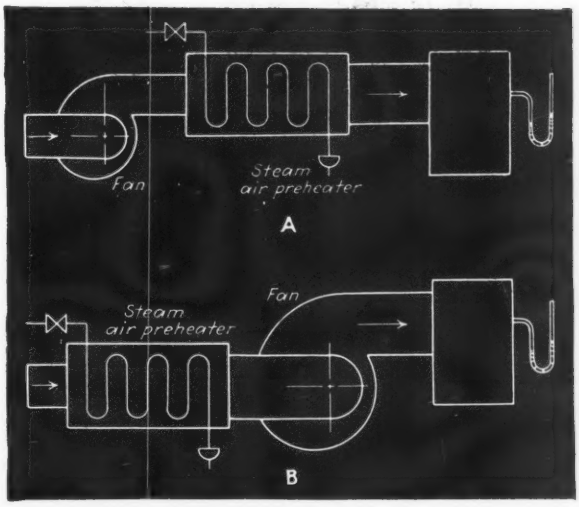


Fig. 1—Fan *b* will consume more energy than will fan *a* to produce the same results

The table contains the results in detail. The temperature rises in the fans are determined from a combination of the relation $pv^k = c$ for adiabatic compression, with the perfect gas equation $pv = RT$. The theoretical horse-power obtained from the heat contents corresponding to adiabatic initial and final temperatures checks the value obtained by the usual pressure-volume approximation.

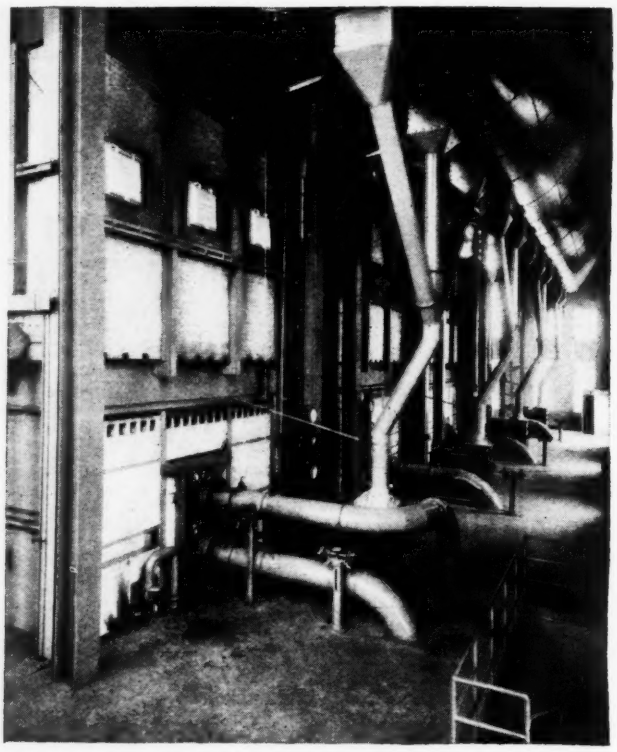
Location of Fan	Before Heater	After Heater
Forced draft required at outlet of system, in water	6	6
Air volume at inlet to system, c.f.m.	100,000	100,000
Air volume at fan suction c.f.m.	100,000	139,400
Air volume at fan discharge, c.f.m.	99,000	137,900
Air volume at heater inlet, c.f.m.	99,000	100,000
Air volume at heater outlet, c.f.m.	137,900	139,000
Air volume at discharge from system, c.f.m.	137,900	137,900
Initial temperature of air, deg. F.	40.00	40.00
Temperature-rise in fan, deg. F.	2.1	2.95
Temperature-rise in heater, deg. F.	197.92	197.09
Final temperature of air, deg. F.	240.00	240.00
Work done by fan, hp.	94.5	132
Heat equivalent of fan work, B.t.u. per min.	4,000	5,600
Heat added by heater, B.t.u. per min.	379,000	377,400
Total heat input, fan and heater, B.t.u. per min.	383,000	383,000

NOTE: The computed volumes allow for changes in pressure as well as changes in temperature.

In an actual case, the fan ahead of the preheater consumes less energy than it would in the other position, but the deficiency is made up as equivalent additional heat required in the preheater. Engineers hardly need to be told that the power saving is worth many times its equivalent in heat, particularly if exhaust or extracted steam is available.

Ten-month Season and Summer

CENTRAL HEAT



Auxiliary power is furnished by the small turbine-generator set

IT HAS long been recognized that the business section of Duluth, Minn., offers an opportunity for profitable operation of a district heating system. The heating season there lasts for ten months, thus giving a better load factor than that usually encountered. Winters are very cold, the number of degree days being about 9,500, and not infrequently steam is required for building heating during the summer.

Duluth Steam Corp., organized to construct a district heating system, started work on a central boiler house of 360,000 lb. per hr. capacity early in 1932, and the plant supplied steam for the 1933 heating steason.

The boiler house, at Lake Ave. and Commerce St., contains four 4-drum boilers, each of 90,000 lb. per hr. steaming capacity and designed for 425 lb. pressure, but actually operating at 230 lb. They are fired with pulverized bituminous coal. The fuel, as received in railroad cars, is sufficiently fine to eliminate the need for coal-crushing equipment.

Coal from the track hopper is fed to a bucket elevator rising vertically outside the boiler-house wall. The elevator discharges to a belt conveyor, which distributes the coal to a 400-ton steel bunker. Three connections are made to the coal bunker for each boiler, making possible a relatively shallow bunker for the live-coal storage secured. The spouts join in a single spout that feeds coal to automatic scales on the operating floor in front of each boiler.

The scales discharge to pulverizers in the basement. Three of these are of 9,000-lb. per hr. capacity and each supplies one boiler. Number 1 boiler is supplied by two pulverizers, each of 4,500-lb. per hr. capacity, making it possible to carry lighter loads on this unit. Coal feed to the pulverizers is controlled from stands on the operating floor at the weight scales. All pulverizers except one smaller unit are driven by steam turbines. One motor drive was provided to permit starting up the plant on purchased current.

Forced-draft fans are integral with the mills and draw air through tubular-type air preheaters having 6,750 sq.ft. of heating surface per boiler. Turbine-driven, induced-draft fans of 60,000-c.f.m. capacity, on the boiler operating floor, draw flue gases down through the air preheaters and through dust chambers below the operating floor. Discharge of the gas is through a common flue at about the boiler drum elevation into a single 13-ft. diameter stack, 250 ft. high. It is of reinforced concrete construction, lined with brick for 40 ft. above the flue gas entrance.

Three boilers have one burner each, Number 1 boiler has two burners, one above the other on the boiler center line. Two oil burners are provided in each boiler for igniting the pulverized coal. They are placed one on each side of the coal burner, at an angle to direct the oil flame under the entering pulverized coal. Fuel oil is stored in a 12,000-gal. tank outside.

Front walls of the furnaces are air cooled, but rear and side walls are water cooled. Inclined sections of the rear water walls are armored, the remainder of the rear wall and the side walls being bare, $3\frac{1}{4}$-in. tubes set on 6-in. centers. Rear walls are fed from and discharged to the mud drums. Side walls are fed from the mud drum through three downcomers and discharge to the front boiler drum through four risers.

Air for cooling the front wall circulates by gravity, entering the wall just below the operating floor and discharging to the boiler room at about the level of the mud drums.

Ashes are removed from the furnace hoppers, dust-collecting chambers under the air preheaters and stack bottom by a vacuum system. Vacuum is created by a steam jet which exhausts to the stack. Air admitted to the ash line at the hopper from which ash is to be removed carries the refuse to a collecting tank and separator on top of a 25-ton ash-storage bin. The valve controlling steam to the steam jet is motor operated and is closed automatically at 90-sec. intervals and remains closed about 5 sec. When steam is shut off, the vacuum breaks and allows a door in the bottom of the collecting tank to open, discharging the ash to the storage bin.

Water is fed to boilers through feed-water level regulators to a $10\frac{3}{4}$-in. O.D. header, from which it discharges through a single row of boiler tubes to a boxed-in section in the mud drum. From this closed section two rows of tubes carry the feed water to the upper rear boiler drum, thus forming an economizer section three tubes deep that has considerable effect in reducing flue gas temperature.

No provision has been made in the steam distribution system for the return of condensate, so that except for a relatively small amount of steam condensed in feed-water heating and station drips, feed water is 100 per cent make-up. City water from Lake Superior is normally used for feed water. A well and two 500-g.p.m. motor-operated pumps provide emergency feed-water.

A feature of this plant is the absence of provision for feed-water treatment in spite of 100 per cent city water make-up. A small amount of boiler compound is used,

Heating Demand Combine to Justify

FOR DULUTH

Equipment Data—Duluth Steam Plant

Coal Handling

Loading conveyor, bucket elevator, distributing belt conveyor, 400-ton steel bunker, coal-handling capacity 75 tons per hour, motor-operated	Brady Conveyors Corp.
Automatic weighing scales, four	Richardson Scale Co.
Pulverizers three 9,000 lb. coal per hr. driven by 150-hp. Elliott Co. turbines, two 4,500 lb. per hour	Strong-Scott Mfg. Co.
High-Low coal burners	Strong-Scott Mfg. Co.
Oil ignition, 2 burners per boiler	Strong-Scott Mfg. Co.
Ash-handling system	United Conveyors Corp.

Boilers and Auxiliaries

Boilers, four 4-drum, 8,510-sq.ft. heating surface, 425-lb. pressure, operated at 230 lb., 90,000-lb. per hr. Bare and armored water walls	Edge Moor Iron Co.
Front walls, air cooled	M. H. Detrick Co.
Air preheaters, 4-tubular type 6,750 sq.ft.	Edge Moor Iron Co.
Induced-draft fan, 4-double inlet	Green Fuel Economizer Co.
Turbine, 73 hp. for above.....	Elliott Co.
Combustion control	Carrick Engineering Co.
Soot blowers	Diamond Power Specialty Corp.
Water columns	Yarnall-Waring Co.
Safety valves	Consolidated Ashcroft Hancock
Stop valves	Crane Co.
Feed water regulators	Bailey Meter Co.
Blowoff valves	Yarnall-Waring Co.
Feed pumps, two 500-g.p.m. driven by Elliott turbines....	Manistee Iron Works Co.
Cold-water, two 500 g.p.m.....	Manistee Iron Works Co.
General service, 125 g.p.m.....	Manistee Iron Works Co.
House turbine generator, 150-kw., 3-phase, 60-cycle, 220-volt, 0.8 p.f., 1,800-r.p.m. generator; 220-hp., 2-stage turbine	Elliott Co.
Feed-water heaters, two 180,000-lb. per hr.	Worthington Pump & Machry. Corp.
Flow meters, flue-gas recorder.	Bailey Meter Co.
Venturi feed-water meter	Builders Iron Foundry
Draft gages, 3-point	Bailey Meter Co.
Pressure gages, thermometers.	Consolidated Ashcroft Hancock
Pipe, pipe fittings	Crane Co.

and up to date the insides of the boilers are in excellent condition, indicating no need for further treatment.

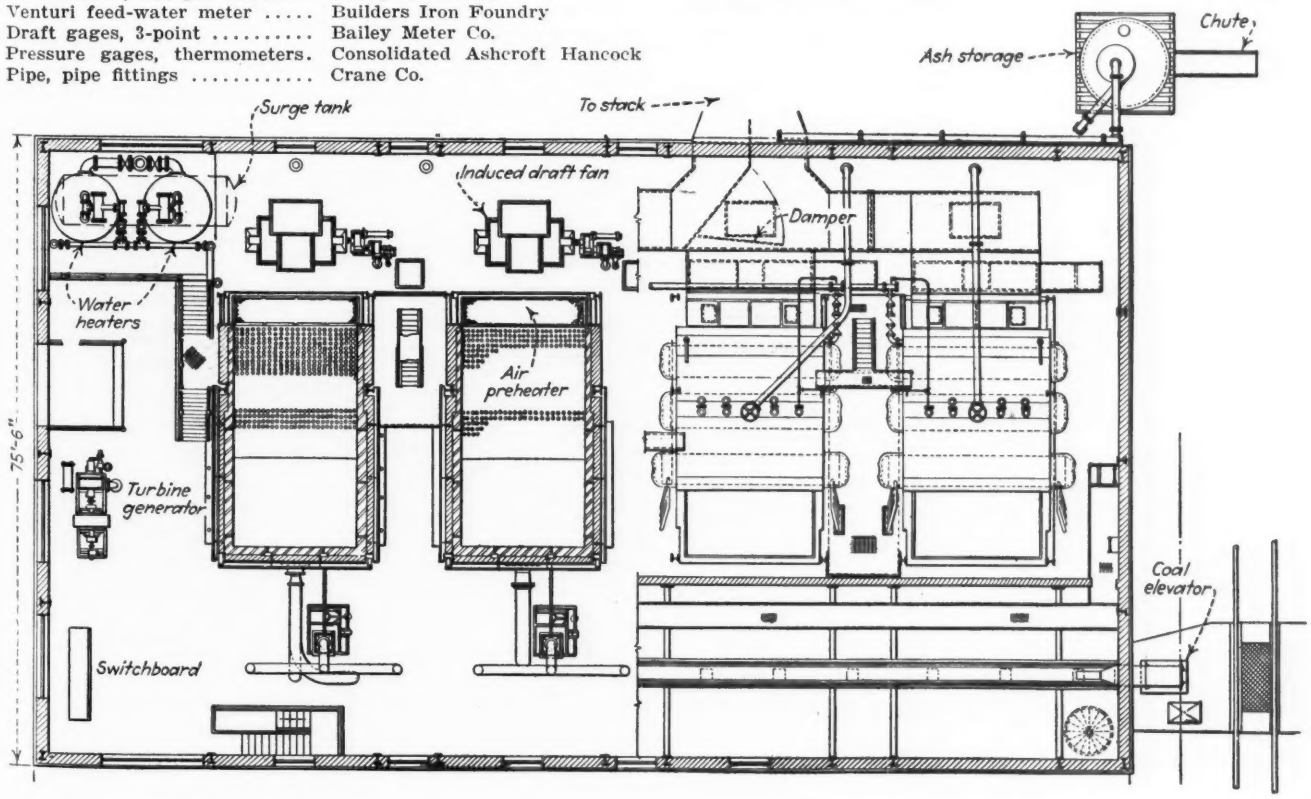
City water pressure is sufficient to deliver water to a 600-gal. surge or storage tank just below the boiler house roof. A vertical sump pump also delivers plant drips to the surge tank from a receiver. Under float control, the water flows by gravity to two feed-water heaters, each of 180,000-lb. per hr. capacity. These feed water at 210 deg. to two 500-g.p.m. turbine-driven feed pumps, which discharge to a 6-in. header at the upper rear boiler drum elevations. Provision is also made so that water may be fed to the boilers through the blow-down piping in an emergency.

All auxiliaries, except the one motor-operated mill, coal-handling equipment, emergency make-up pumps and a service water pump, are turbine driven and exhaust to the feed-water heaters.

Electric energy for lighting and the few motor-operated auxiliaries is furnished by a 150-kw. turbine driven alternator. This unit operates at 1,800 r.p.m. and furnishes 3-phase, 60-cycle current at 220 volts. Emergency electricity is from a stand-by utility connection.

Steam is delivered from the center drum of each boiler through an 8-in. line to the 12- and 16-in. station header, just below the boiler operating floor. This location permitted valves in the boiler leads to be placed so that they may be easily operated from the boiler operating floor, and in addition steam leaves the plant at this elevation under an elevated roadway.

The district heating project in Duluth was initiated by J. J. Dwyer, consulting engineer, who made preliminary surveys and plans. Plans were checked and details worked up by the Pillsbury Engineering Co. The Edge Moor Iron Co., as general contractor, furnished the boilers and fuel-burning equipment, and A. R. Robertson, as subcontractor, furnished and installed plant piping and mechanical equipment. Operation of the system is under the management of R. L. Fitzgerald, vice-president and general manager of the Duluth Steam Corp.



MAKE SOOT BLOWING EASY

By C. G. ROBINSON

SOOT is a good insulating material, hence flue-gas temperature for a given boiler load increases if soot is permitted to remain on the boiler tubes. The rise in flue gas temperature after a day's operation without blowing off soot may be as much as 75 deg. F. Fresh soot accumulations are easily blown off, but if allowed to remain on the tubes, it often fuses or cakes, making its removal difficult. It follows that soot should be blown at frequent intervals—from one to several times a day, depending upon the fuel used and conditions of firing. On the other hand, blowing soot too frequently is also a source of loss because of the excess amount of steam used and the too frequent cooling of the boiler occasioned by the large amount of excess air admitted during the soot-blowing process. It follows that for each installation there is a right interval between soot blowings.

Soot blowing is a highly important factor in efficient operation of the boiler room, but all too often it is considered a disagreeable duty to be finished as soon as possible. This attitude is generally caused by the excessive heat and otherwise disagreeable conditions where the soot blowers are located and because they are hard to turn due to warped elements or defective swivel tubes. The best way to insure a thorough job is to consider human nature and make soot blowing easy.

Dry air or dry steam should be used in operating soot blowers. Wet steam or air causes some of the soot to stick and cake, making its removal difficult.

Soot-blower lines are almost invariably drained to the atmosphere. The magnitude of these losses is illustrated in a power plant having an average of eight boilers in operation 24 hr. a day, 365 days a year. Soot is blown in each boiler three times a day, once each eight hours. There are two ½-in. soot-blower drains to each boiler, one on each side, and steam is allowed to blow through these drains for three minutes before each blowing of soot. This is equivalent to allowing steam to blow through a ½-in. line, from boiler to atmosphere, eighteen minutes per day per boiler, or for the eight boilers two hours and twenty-four minutes a day. Imagine the action that would be taken were the watch engineer to open a ½-in. line from the main steam header to the atmosphere, and leave it open for two hours and twenty-four minutes each day—which is equal to 876 hr. or 32 days and 8 hr. per year. Say the steam pressure is 300 lb. per sq. in. gage, and coal costing $4.25 per ton in the furnace, evaporates 8.4 lb. of feed water per pound. By Grashof's formula, the pounds of steam wasted in a year would be 2,625,985 lb., the cost of the coal would be $664, the cost of the water wasted would be $31.50 at 0.10 per 1,000 gal., the total cost per year would be $695.50, and this capitalized at 16 per cent is $4,350.00.

This is good money in any man's language, and is well worth going after, furthermore, as every operator knows, 90 per cent of soot-blower maintenance is caused by improper drainage. The system shown in the figure is the best that I have so far observed. The drain from the drip receiver (marked *A*) is closed before the soot-blower header valves are opened; with this exception the lines are warmed up and pressure put on them in the usual way. Any condensation occuring in the lines will drain to the receiver and remain there while soot is being blown. When through blowing soot, the header valves are closed and the drains are opened and discharged to a hotwell or surge tank. The only loss incurred is the heat in the condensate that collects in the receiver.

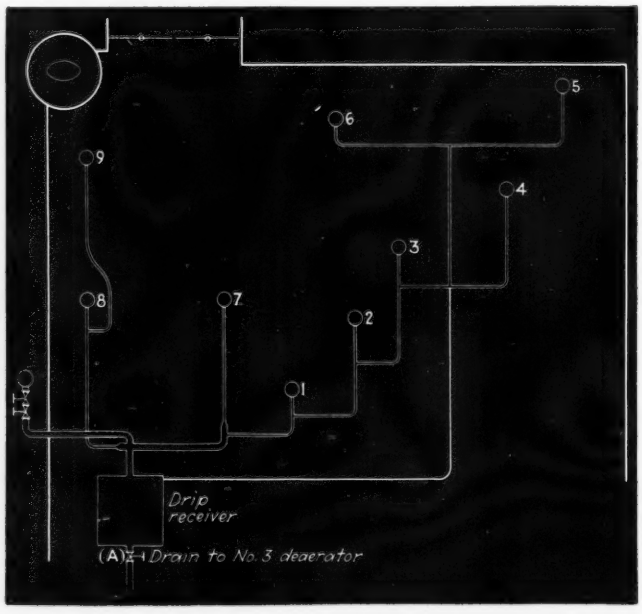
A drip receiver installed in the soot-blower system as shown, and used as suggested, will not only cut to a minimum the losses due to soot-blower drainage, but will decrease maintenance by practically eliminating the admission of water to the elements.

The drip receiver is easily made—a piece of 6- or 8-in. pipe 24 or 30 in. long, having a ½-in. plate welded to each end, with suitable openings tapped for the necessary fittings, and tested with boiler feed-water pressure, will do very nicely. The low cost of making and installing the drip receivers, and the savings effected by them, more than justify their adoption.

Soot-blower lines should be lagged, and the lagging kept in repair. It is a good idea to install tin shields around all lagged piping that soot-blower chains are likely to come in contact with. This saves the lagging and is good practice, both for economy and efficiency.

Soot blowers should never be yanked into action rapidly; the cam should be brought against the lifter slowly, and it is well to pause for a second just after the valve has opened slightly. This will allow the element to cool to the temperature of the steam a little more slowly and thus lengthen the life of the element.

Make the soot blowers operate easily, keep their location as cool as practical, instruct the operators in the proper way to do their job, get them to understand and appreciate the importance of blowing soot, and soot-blower satisfaction and economy will be assured.

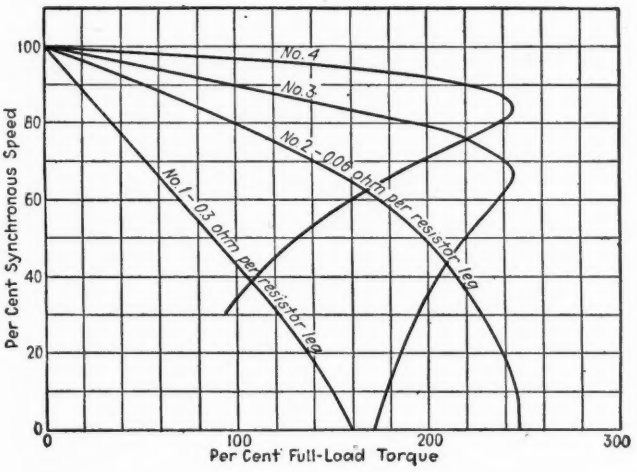


Starting A Wound-Rotor Motor

WITH RINGS SHORTED

By R. F. EMERSON

Industrial Engineering Department,
General Electric Company



ONE question occasionally raised is whether or not a wound-rotor induction motor will start when its rings are short-circuited. The answer usually is that the starting characteristics are bad and that the rotor is likely to lock if it happens to stop on a dead point. A rather unusual case of this sort came to the writer's attention. A 10-hp. wound-rotor induction motor with rings short-circuited would start a load having high static friction, but could not start the load with the starter arranged to give 160 per cent starting torque. In other words, the motor with rings short-circuited was able to exert more than 160 per cent of full-load starting torque, contrary to what might be expected.

In analyzing the operating data, it was found that this particular motor was designed to give its maximum value of starting torque when the starter provided a star-connected external resistor of only 0.06 ohm per leg. Referring to the figure, No. 2 speed-torque curve gives maximum starting torque and is obtained with 0.06 ohm per resistor leg. With 0.3 ohm per leg of resistor, curve No. 1 is obtained, the motor exerting 160 per cent torque at zero speed. By test it was proved that this was not enough torque to start the load. Evidently, the motor was operating on a speed-torque curve similar to curve No. 3 which intercepted the zero speed curve somewhere between No. 1 and No. 2, instead of operating on the fundamental curve No. 4, which had very poor starting characteristics.

Evidently there was sufficient resistance in the connections and switch contacts used for making the short-circuit connection to permit the motor to exert considerably more torque than 160 per cent of full-load value. It should be noted that gradually reducing 0.3 ohm in the resistor increases the starting torque until 0.06 ohm resistance is reached. After that, any further reduction in the value of the secondary resistance will begin to reduce the starting torque. The probability was that the external short-circuiting connections introduced a value of secondary resistance less than 0.06 ohm, but still high enough to get more than 160 per cent starting torque. When starting on any curve less than 0.06 ohm, it will be noted that torque always increases to maximum first, before reducing to the full-load running torque as indicated by curves Nos. 3 and 4. With any value of resistance greater than 0.06 ohm, the starting torque is always maximum at starting and reduces in value as the motor speeds up, as indicated by curves Nos. 1 and 2.

Thus, theoretically, a wound-rotor induction motor may have very poor starting characteristics when starting with rings short-circuited. However, there may be cases where the secondary resistance required to get maximum torque may be so low and the external-connections used to short-circuit the rings may have a resistance so great, that high starting torque will be obtained.

Feed-Water Supervision Pays

By BURTON W. WHEELER

● THERE is no doubt that the cost of good treatment of boiler feed water is high, but results are generally uniform and satisfactory. The cheaper first-cost treatments usually present the rest of the bill later in the form of greater maintenance cost and interrupted production.

An actual condition that shows clearly the difference between poor treatment and good is the record of a plant of eight B.&W. boilers operating between 150 and 175 per cent of rating. Using a certain compound, the following tube failures occurred over a period of 23 months.

					1930						
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
21	8	10	2	7	25	0	2	0	9	22	58
					1931						
11	35	35	15	22	..	..	..	..	..	3	..

Even these figures do not tell the whole story. With no spare boilers and sometimes three down with bad tubes, life in the boiler room was a nightmare.

It was decided to use a different treatment, one requiring closer and better supervision and costing more to use. This treatment was started May 4, 1931. Renewing of tubes stopped, with the exception of three tubes which were then bad but were not removed until boiler inspection in November. Since November, 1931, no new tubes have been put in although the boilers have been practically in constant use.

The cost of the two treatments can be compared as far as it applies to the boiler room. To compare them accurately as applied to the whole plant was impossible because, under the old treatment, part of the plant had to curtail production for the lack of steam when boilers were down.

MAKING THE

By An Operator Unafraid of "Bad Coal"

The author of this article is a college-trained engineer who, due to the depression, has been handling the stokers of a large industrial power plant as shift operator. Recognizing that the economic results obtained with a stoker are largely in the hands of the operator, he has applied his engineering skill to the job and here relates his observations on underfeed stokers

"WHAT is the best method of burning coal?" is a question which has no universal answer. The "bin system" and the "unit system" of pulverized coal, overfeed, underfeed and chain-grate stokers and even hand-fired grates all have specific applications. Sometimes it is possible to pick one method of firing as unqualifiedly the best for a particular situation. There are kinds of fuel, for instance, which can be burned better on chain grates than in any other way. Usually, however, it is not possible to make a decision that can not be disputed by advocates of some other form of firing.

The net difference in the final cost of producing steam may be so small that a change of one or two per cent in an estimated efficiency may change the decision. Correctness of the designer's decision may therefore rest on the skill of the operator.

The question of the proper thickness of a stoker fire has always been a source of discussion. Some maintain that a heavy fire is better, because it allows a margin of safety in holding the load when steam demand suddenly increases. Others claim a thin fire is better because the air for combustion and coal can be more intimately mixed and, therefore, a quicker response to changes in load conditions can be effected. However, no general rule can be made for the exact thickness of a fire. Proper thickness is determined by the fineness of the coal, its clinkering and coking characteristics, the degree of agitation of which the stoker is capable, the amount of ash in the coal, and the load on the unit.

The operator keeps track of the fineness of the coal by watching the stoker hopper, as well as the fire itself. If the coal is unusually fine, the secondary ram stroke should be shortened and the air at the front section of the stoker reduced. This causes the fire to become heavier and prevents large holes due to spouting of air through the fuel bed. This is the most serious difficulty with fine coal, especially at higher ratings when the forced-draft pressure is increased.

With fine coal, the operator's problem is to keep the grates covered and the mass of fuel progressing to the rear of the stoker, supplying necessary air and agitation to burn out the carbon completely by the time it reaches the ash pit.

If a coal has a serious clinkering characteristic, the operator will soon discover that a heavy fire is disastrous, that the fuel bed can not be moved toward the ash pit, and that the retorts plug up with a mass of clinkering coke and ash. A clinkering coal usually shows its fusing aspects first at the rear quarter section of the stoker and especially above the extension grates and ash pit. Usually a slagging mass of clinker, black in color, and having a ridged, "pop corn" outline shows itself. Often before a clinker can be seen, the incandescent fuel at the rear of the stoker has a thin black fringe all over the outer part of the coal. This is the clinker danger signal.

Prompt and vigorous action is imperative. A fire full of clinkers creates a critical situation. Often the clinker will adhere to the top of the tuyeres throughout practically the entire length of the stoker. It blocks the air, causes incomplete combustion, smoke, and disaster to the stoker iron, as well as to the operation of the stoker. If the ash fusion temperature (softening temperature) is very low (1,900 to 2,200 deg.), the clinker shows itself extending over the ash pit clear back to the rear wall, having the shape of the tuyere top. The fire becomes extremely heavy due to air being shut off from the fuel bed, and smoke can be seen rising from the fire and passing through the lower rows of boiler tubes.

Clinkering in the retorts is also serious. Often this condition results in a rupture of some part of the stoker due to a moving part being held fast by the clinker. Clinkers in the fuel bed are caused by the ash melting and cooling before it has been moved along the stoker to the ash pit. If a fire is heavy, the ash and unburned coal and coke readily mix; the ash fuses with the coal and coke, forming a hard mass on cooling.

There is always present a mixing of the ash and coke due to the fact that some green coal and coke will be pushed to the top of the fuel bed after coke in a section farther forward in the stoker has been consumed and reduced to ash. This ash and the coke and

MOST OF UNDERFEED STOKERS

coal, pushed to the top in a lower section, then come in contact. The resultant mixture forms a mass that is hard to move and obstructs the progress of the coal to the ash pit. This occurs more intensely when a heavy fire is maintained.

If the fusion temperature is low, the ash in the coke will run in a heavy fire and mix with the incandescent coke. It will then filter through the coke to a cooler level of the coal bed, acting as a cement and preventing part of the coke from rising to the top of the bed and being consumed. Instead of rising, the mass will settle either on a tuyere or in a retort, causing the troubles described.

If a coal with ash of this character is being burned, the operator should keep the fire as thin as possible, and move it faster by increasing the stroke of the secondary rams. He also should keep the ash pit low to prevent clinkers from starting at the pit and backing up into the retorts causing a stoppage.

To have proper agitation is important, and unless a stoker is designed to agitate the fuel properly, the available grades and kinds of coal may be limited. Excessive agitation is not desirable, since it allows the fire to burn too deeply into the retort, causing excess air in the furnace. Also the stoker iron, both in the retort and on the sides of the tuyeres, is subject to unnecessary burning. Excessive agitation is noticed when the fire has a pronounced wavy appearance directly above the retorts and tuyeres.

Modern stokers are designed so that any agitation needed can be obtained. For one particular stoker installation, the most efficient load is that which gives a combustion rate from 28 lb. to 35 lb. per sq. ft. of grate surface per hour when good coal is burned. At this rating, agitation is easy to obtain without materially shortening or lengthening the secondary ram strokes. Proper agitation is more easily obtained at high loads than at low because of the higher stoker speed.

When a coal cokes and clinkers in an extreme manner, there is always a probability of trouble at the higher loads due to higher furnace temperatures. Under these conditions, the greatest amount of agitation is necessary to keep clinkers from adhering to the stoker iron. With this poor type of coal, at lower loads and lower stoker speeds, trouble is likely because the fuel bed can not be agitated properly. Under this last condition, speeding up the stoker for short periods helps to produce the proper agitation and to eliminate the possibility of troublesome clinkering.

If the ash content of the coal is relatively high, greater agitation is necessary than if the ash content is normal. Correspondingly, the fire should be kept thinner and the amount of air less. The fire in this case moves faster toward the ash pit.

The proper level of the ash pit is a most important item. This level should be kept always such as to allow the fuel bed to move without interference of ash or clinkers in the pit. If the ash is too high, it offers resistance to the movement of the fire, with the result that the retorts become plugged with coal and coke and the tuyeres become covered with a mass that is liable to stick to the iron. As a result combustion air may be cut off and moving parts of the stoker broken.

The fuel bed normally covers the extension grates for about 4 inches and slopes off the bottom of the extension grates to a point half way across the ash pit where the level of the ash is just below the end of the grates. This level will allow the coal bed to move freely to the rear. If the ash has a decidedly low fusion temperature, it becomes necessary to keep the ash in the pit lower than this to allow the clinker to break off due to its own weight. Otherwise, it will extend across the pit to the rear wall and form an obstruction to the progress of the fuel bed. The ash pit, of course, should have the same level throughout its length, otherwise the fuel bed becomes uneven and hence unwieldy.

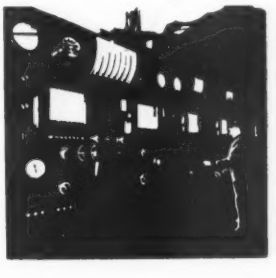
Modern stokers are equipped with clinker grinders, single-roll, double-roll and triple-roll, depending on the size of the boiler unit. In large installations, it is advisable to install clinker grinders rather than hand- or steam-operated dump grates. Clinker grinders are more efficient because they operate nearly continuously, and because no extreme amount of excess air passes into the furnace from the ash pit as happens when dumps are operated. Much trouble is experienced with dump grates from clinkers sticking across the dumps to the rear wall, requiring a great deal of slicing and barring before the ashes are actually discharged. This trouble is rarely encountered with properly designed and operated clinker grinders. There is a much lower loss due to carbon in the ash, which is enough to justify their use, even in some relatively small installations.

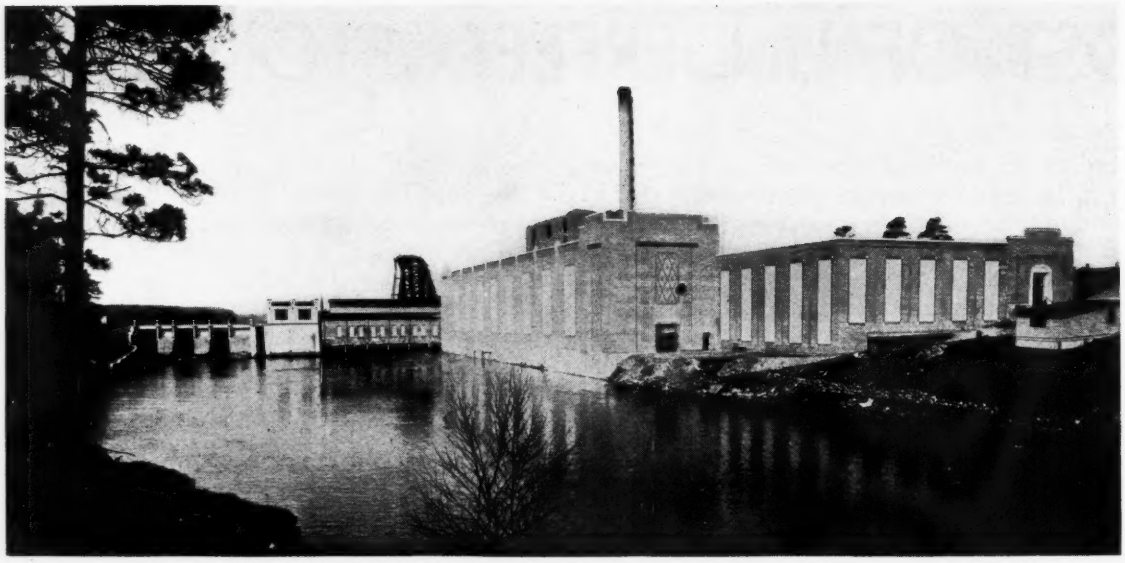
Breaker plates in the ash pit are desirable because the area of the pit discharge at the rolls can be increased or decreased. If a mass of clinker and ash is unable to pass through the pit, the breaker plate may be opened to allow this mass to pass. It is a great help in maintaining the proper ash pit level.

An experienced operator fixes a number of points along the sidewalls of the furnace to estimate the depth of the fuel bed. To say how deep the bed actually should be at certain loads and under all conditions would not be practicable; but, by arranging the feed and controlling the fire to follow these predetermined points along the sidewall and the rear wall with reference to the ash pit, the operator can increase or decrease the fuel-bed thickness and be assured, by watching these fixed points, he is accomplishing the desired results.

For instance, while operating a stoker in conjunction with a 12,000-sq.ft. boiler at a continuous output of 100,000 lb. of steam per hour, with low-volatile coal, the following points were selected as representing the best fuel bed depth:

One point just below the bottom of the front observation door, a second point 20 in. below the middle observation door, and a third point about 12 in. below the rear sidewall observation door. Points 48 in. below the observation doors in the rear wall were used for determining and maintaining the proper ash pit level.





WINDOWLESS PAPER MILL

HEATED WITH VENTILATION EXHAUST

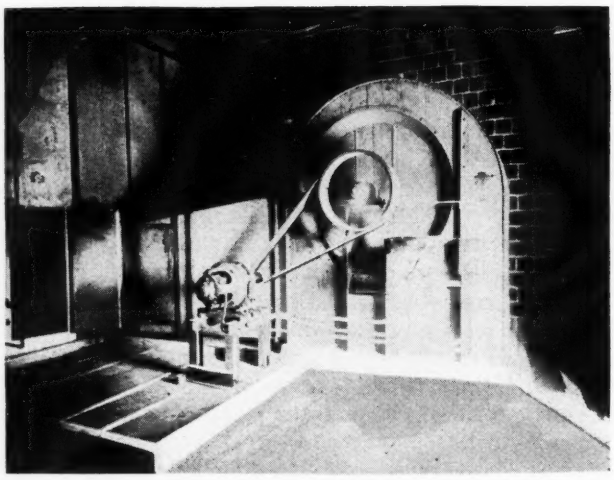
By A. J. KULL
Chief Engineer, Blandin Paper Company

AIR conditioning, so that the paper drying process may be carried out to best advantage, is one of the chief problems of the paper mill. During the 24 hr. of the day, both light and temperature within a windowed building vary within wide limits. Consequently, when Blandin Paper Company was installing its new 156-in. paper machine, it appeared best to control the heating, lighting and the ventilation by eliminating windows entirely.

The 320x50-ft. building, with a full basement, would, however, look drab and cold without some decoration, so large panels of white brick with harmonizing colors for borders were built in, as shown above.

A circulation of 120,000 cu.ft. of 70-deg. air per min. is required by the new paper machine, which turns out 90 tons of paper an hour, to remove the moisture driven off the paper during the drying process. Inasmuch as ventilation must needs be entirely taken care of by fans, it is easy to reclaim required building heat from the hot moist air drawn from the hood of the paper machine. To accomplish this, four galvanized ducts draw the hot, moist air from the hood into the penthouse by motor-driven fans. Here the air is passed through a copper economizer. Cold air taken from the outside is forced through the economizers, but separated from the moist air by copper sheets. This fresh air absorbs the heat from the exhaust air and is circulated by variable-speed fans through ducts to different parts of the mill.

At present only three of the four stacks discharge to the economizer, and it is found from tests that with 45-deg. outside temperature, the heat recovered is equivalent to 5,800 lb. of steam. When the temperature ouside is freezing, the heat recovered is equivalent to 7,500 lb. of steam, and at zero degrees outside, 10,400 lb. per hour.

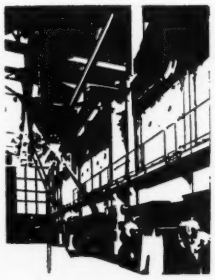


One of the fans in the penthouse discharging air to the economizers

The heat recovered is sufficient to heat the entire new addition without the use of any additional steam, except on a few days when the temperature drops to below —10 deg. This has resulted in a considerable reduction in the cost of heating these buildings, and the air condition is better than in the old mill.

Contrary to what might be expected, the cost of lighting is not excessive, even though lights are used 24 hr. a day. It had been found impossible to keep the lights turned off in the old building where windows are used, and the lighting effect varied according to the sun. In the new mill, a lower foot candle has been adopted because lighting is uniform and the workmen are not subjected to the strain of varying light intensity.

H. G. LYKKEN* DEMANDS A "NEW DEAL" IN BOILER SPECIFICATIONS



The Logic of It

1. Since the firing unit is but one element of a complete boiler unit, why should the manufacturer of the stoker or pulverizer be asked to guarantee over-all efficiency?

2. The firing-equipment bidder must be permitted to specify the furnace dimensions if he is to be held accountable for combustion efficiency.

3. Furnace temperature and every temperature effect are boiler considerations and responsibility.

4. Responsibility for heat liberation should be on the stoker and pulverizer manufacturer, but within specified furnace dimensions.

5. Responsibility for heat utilization must fall on the boiler manufacturer.

WHO should guarantee the over-all efficiency of a boiler installation? The usual specifications require the firing equipment manufacturer to make this guarantee. For this there is no excuse except custom.

When a job comes up, scores of boiler companies send in their guaranteed exit temperature, on the theory that the firing equipment manufacturer will guarantee the over-all efficiency of their boilers to the customer.

Yet there is no uniformity as to the height, width or length of furnace, amount or distribution of radiant-heat-absorbing surface, furnace construction, radiation losses, draft conditions at the entrance to the first pass, tightness of setting—just exit gas temperature at an assumed CO_2 at the exit, at various ratings.

The deficiency in the average boiler installation is not in the firing equipment, but in the furnace. If we once and for all could get rid of the hoary fallacy that the stoker or pulverizer is a coal-burning device, charged with everything we associate with the burning of the fuel, we would realize that combustion depends as much upon the furnace design as upon the firing means.

The stoker will feed the coal and air to the furnace. If it is a first-class stoker, it will do this in accurate proportions. It will gasify the fuel and supply the proper over-fire air to burn the gas. When it has done this, it is through. The actual combustion takes place in the furnace space above the fuel bed. If there is not height enough to give adequate mixing and complete combustion, nothing can be done by the stoker to remedy it. If uncontrolled gas flow in the furnace causes stratification and stream-lining to the boiler pass, it is beyond the scope of the stoker. If the furnace temperature is so high, due to inadequate heat-absorbing surface in the furnace, that the very fuel bed fuses to a mat, it is not a stoker fault.

Again, why should the stoker manufacturer do the guessing as to the radiation losses through the setting and even from the boiler itself? Why should he guess as to the air infiltration in the setting that is part of the boiler? Why should he come between the purchaser and the boiler manufacturer if the latter figures the heat absorption of the boiler too high?

What has been said about stokers applies equally to pulverized coal equipment. When this equipment has discharged to the furnace an accurately proportioned mixture of properly pulverized coal and air, thoroughly mixed in a controllable flame pattern, it is through. Combustion then becomes a function of the furnace and the heat utilization a function of the boiler or, rather, of the combination of the furnace and boiler.

Every condition affecting combustion in the furnace, and every item pertaining to *utilization* of the heat, is beyond control of the firing-equipment manufacturer. With open competition as to boilers and little or no information regarding settings, boiler room arrangement and space, there is no possible way of making any intelligent forecast as to most of the factors affecting over-all efficiency. The flue gas temperature—the only one given in most cases—is the least important of the variables, since the greatest possible variation here is almost negligible.

When new firing equipment is to be installed under an existing boiler, the purchaser can, of course, legitimately ask for an over-all guarantee of results from its manufacturer. The results can be calculated, based on known conditions.

Again, when firing equipment is called for on a new installation of a specific boiler, furnace and setting—where every detail affecting combustion and heat utilization is shown and specified—there may be some excuse for competitive guarantees from the firing equipment manufacturers, based on over-all results. Yet, even in this case, why should firing equipment guarantees be based on over-all results?

Is it not about time to get these specifications on some logical ground? Have we now not sufficient knowledge of boiler room apparatus so that each item can be charged with its own legitimate responsibilities?

In latter years, boiler manufacturers have added firing equipment, and firing equipment manufacturers have added boilers to their line, in order to offer unit responsibility to a public sick of the scrambled results of divided responsibility under the present meaningless specifications and buck-passing guarantees.

The engineering public desires open competition on

*The author is connected with the Strong-Scott Manufacturing Company, Minneapolis.

boilers, firing equipment and every item entering into a complete plant, and wants to be free to choose, at least as between the major items. It should have this privilege, and it is the responsibility of the specification writer to know the function of each item and fix the responsibility of performance where it belongs, so that there can be no question when it comes to correlating the various items in the completed plant.

The functioning of the fuel-firing equipment is definite. A stoker or pulverized coal equipment manufacturer can legitimately be charged with the responsibility of guaranteeing everything pertaining to heat liberation; that is, the combustion efficiency. With the coal specified, at the rating specified and with a stipulated amount of excess air (say, 30 per cent), a definite combustion efficiency can be demanded and guaranteed.

Since, for any given fuel, rating, type of firing equipment and method of firing, there must be a definite minimum furnace width, length and height, to obtain a given combustion efficiency, these items must be specified by the bidder as a condition of the guarantee. There may also be other requirements, such as draft control, possibly control of flow of the gases in the furnace, with arches for certain types of stokers.

By stipulating the furnace requirement, the combustion engineer can specify definitely the percentage of the theoretical heat value in the coal that can be liberated in the furnace, whether it be 75 per cent or 99 per cent, depending upon the type of equipment and general set-up. Combustion efficiency is the theoretical heat in the coal less any combustible remaining in the ash pit or going out the stack, a definite thing and not too difficult to determine.

The responsibility for the *utilization* of the heat lies with the boiler, as does every detail of the guarantee as to the utilization of the heat when once liberated. There will be the flue-gas losses depending upon the efficiency of the heat absorption of the boiler. There will be losses due to radiation from the setting and to dilution of the gases by leaks in the boiler setting. All are elements pertaining to the function of the boiler.

The setting should be an integral part of the boiler contract and one responsibility, at least as to design. Aside from the space and dimension requirements and other factors that may affect combustion the furnace necessarily is an integral part of the boiler design. One-half of the heat absorbed by the boiler must be absorbed by the boiler surfaces exposed in the furnace, and it is boiler surfaces properly distributed as to the furnace or in the furnace that must keep the temperature in all parts of the furnace within tolerable limits for the CO_2 and rating specified. Furnace temperature and every temperature effect are a boiler consideration and responsibility.

Heat liberation can vary from 50 per cent to 99 per cent of the heat in the fuel. The efficiency of absorption or exit flue-gas temperature will not vary over 5 per cent in boilers of the same class. Consequently, consideration of heat liberation should come first. The responsibility can be placed upon the firing-equipment manufacturer, who can and should guarantee a definite efficiency or completion of heat liberation, with such space limitations in the furnace as it may be necessary to make, but that he necessarily accepts and stipulates in his bid. The combustion engineer must fit the furnace dimensions to the firing equipment and firing conditions. This done, there is an unequivocal responsibility placed for the major item that affects over-all efficiency.

The responsibility of the second item that affects over-all efficiency can then be placed where it belongs. If 98 per cent efficiency of liberation (combustion efficiency) is guaranteed by the firing equipment manufacturer in an accepted "space," and the boiler manufacturer guarantees the absorption of 75 per cent to 85 per cent of the heat liberated, depending upon the character of fuel and design of boiler, we have the whole story and definite division of responsibility. This must necessarily be based on the same fuel, percentage of excess air and ratings.

A competent engineer would know what the furnace requirements are for any method of firing or type of equipment. He would also know what the designers of these various types of equipment would require for their particular equipment.

The "new deal" calls for bids on firing equipment, with furnace dimensions and conditions to fit that particular equipment and the function it is to perform. It calls for bids on boilers that fit or embody such furnace requirements and conditions necessitating variation in the boiler design. *The guarantee of the one is to be based on heat liberation, of the other on heat utilization.*

32,000-Hp. Francis Turbines

APPLIED TO 1100-Ft. HEAD

By GEORGE A. BOVET
Engineer, Geneva, Switzerland

ON THE Ticino River, in Switzerland, the Piottino development of the Officine Elettriche Ticinesi uses a gross head of 1,100 ft. Each of the two turbines installed has its independent penstock 1,830 ft. long, having a diameter of 61 in. at the intake and 51 in. at the power house. The corresponding water velocities, with rated load on the turbine, vary from 14.5 to 20.5 ft. per sec. Penstock plates range from 5/16 to 1 in. in thickness. Plates 27/32 in. thick and less are assembled by autogenous welding and those over 27/32 in. thick are lap-welded by the water-gas process.

The two francis turbines are rated at 32,000 h.p. and operate under a net effective head of 1,070 ft., the next highest head to which francis turbines have been applied.

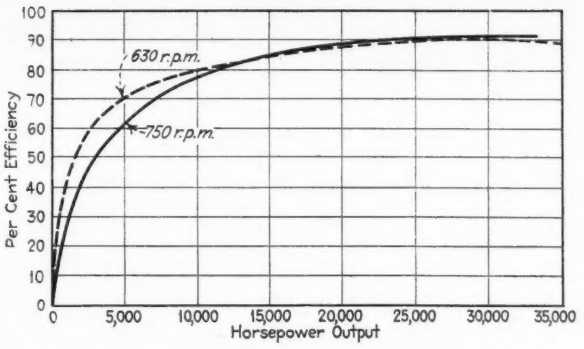


Fig. 1—Test efficiency curves at 630 and 750 r.p.m.

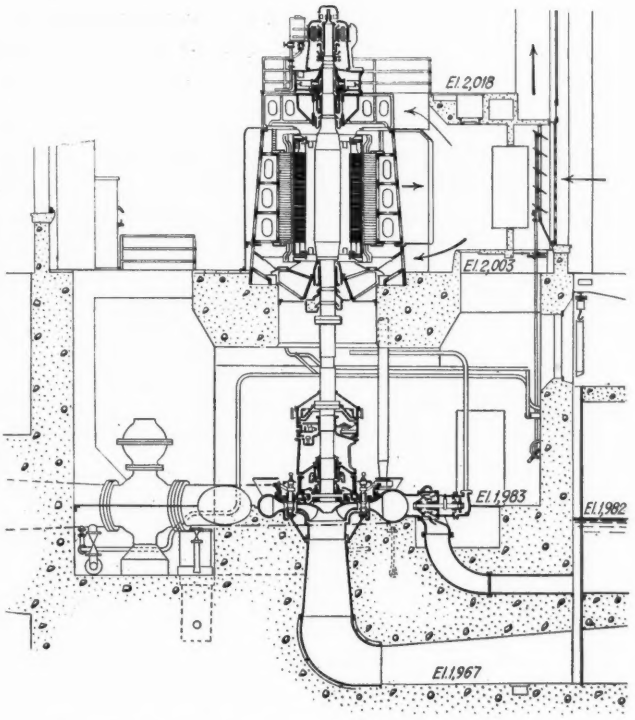


Fig. 2—The turbine can be dismantled without disturbing the generator by removing a section of the shaft

The generators can be connected to either of two transmission lines, one a 50-cycle line leading into Switzerland over the St. Gothard Pass, the other a 42-cycle line leading in the direction of Italy. The turbines have consequently been designed for a normal speed of either 750 or 630 r.p.m. A change from one frequency to the other being made by simply changing the position of the speed-adjustment device of the governor. An official test of these turbines exceeded 90 per cent maximum efficiency at both speeds, Fig. 1.

The static draft head on the turbines is practically zero, for the exit of the runners has been placed on about the same level as the lowest tailwater elevation. The runners are made of special high-tensile bronze and fitted with shrunk-on steel wearing rings.

Because of the erosive nature of the sand in the water and the high head, it was assumed that the runner-clearance linings would have to be renewed every few years to maintain the efficiency. For this reason, the turbines have been designed so that they can be entirely dismantled without removing the generator rotor. A section of shaft between the turbine and generator can be removed to allow dismantling the turbine.

The speed-governor actuators are electrically driven by induction motors connected to the generator terminals through step-down transformers. In case of failure of the actuator motor, the turbine gates close automatically to no-load opening. The governor oil pump is driven from the turbine shaft by gears which also actuate the overspeed-limit device.

Relief-valves with which the turbines are provided are fitted with hydraulic control. Fig. 3 shows the diagrammatic arrangement of governor and relief-valve in this type of control. Water pressure in the turbine casing exerts a thrust on the relief-valve obturator *A*, in the direction of opening. The relief valve is normally maintained closed by oil pressure in cylinder *C*, which produces a closing thrust greater than the opening thrust due to the water-pressure.

When load is thrown off, distributor piston *P* moves to the left and releases pressure oil from cylinders *S* of the servomotor. Piston *E* is displaced to the left by oil expelled from cylinder *C* by the water-pressure on relief valve *A*. The energy required for closing the turbine gates is therefore furnished by the opening movement of the relief-valve. A rapid closing of the turbine gates is impossible without a corresponding opening of the relief-valve. The subsequent closing velocity of the relief-valve is regulated by diaphragm *D*.

The units are provided with brakes consisting of eight asbestos-lined shoes applied radially to the rim of a water-cooled wheel fixed to the coupling flange of the turbine shaft, by servomotors using the penstock pressure.

Ahead of the turbine casings are spherical valves, hydraulically operated. In open position, the valve presents a smooth uniform pipe section free from obstructions. When completely closed, water tightness is ob-

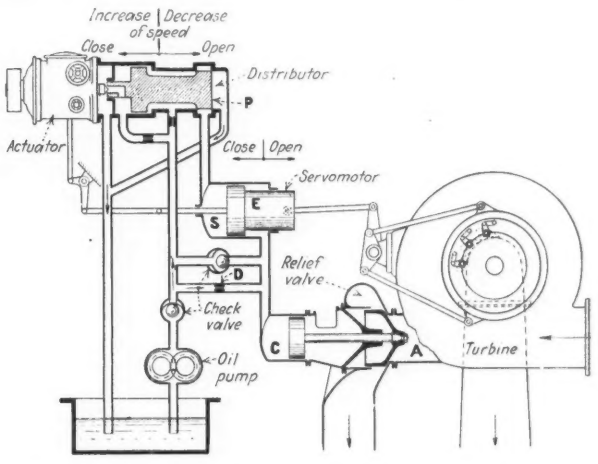


Fig. 3—Diagram of speed-governing and pressure-regulating equipment

tained by a gun-metal ring groove cut in the valve body and applied by water pressure to a corresponding ring on the moving part of the valve.

The 23,000-kva. vertical-shaft generators were furnished with their suspension bearings by Brown, Boveri & Co., Baden, Switzerland. The turbines, governors and relief valves were designed and built by Ateliers des Charmilles, S.A., Geneva, and the development was designed by and constructed under the supervision of Motor Columbus S.A., Baden, to which the author is indebted for the illustrations.

A YARDSTICK FOR WIRE-ROPE SAFETY

Are the ropes safe? This question frequently must be answered by every wire-rope inspector. The method here described was developed after several years of research work and allows the remaining strength of used wire rope to be calculated. This provides a yardstick to determine rope safety

EXTENSIVE study has shown that it is possible to develop methods by which the remaining strength of wire rope may be estimated, and consequently its safe life determined. This article is based upon research work done in the field and laboratory by the engineers of the John A. Roebling's Sons Co., in co-operation with the Otis Elevator Co., to develop methods of estimating the remaining strength of used wire rope. When using these data it should be understood that they have been developed for one manufacturer's ropes, and are not intended to be used for other makes of ropes.

There are four factors that must be considered when determining the remaining strength of a used wire rope: Corrosion, broken wires, abrasion and deterioration due to internal wear. Of these, the effects of corrosion cannot be safely determined. Its effects are mostly on the inside of the rope and are not readily ascertained by observation. One sample of used rope that was estimated to have 92.5 of its catalog strength tested to only 60 per cent when it failed. An examination of this sample showed that it was badly corroded on the inside. Furthermore, if a rope has been attacked by corrosion, when the wires start to break they may fail quite rapidly. Because of these conditions, a rope that has corroded should be removed on the first signs of distress.

Corrosion can be prevented in most cases by proper lubrication. In general, corrosion is not a factor in the life of elevator ropes.

Broken wires, the second factor in the remaining strength of a wire rope, are generally easily determined by inspection. Except where corrosion is a factor, broken wires occur on the outside of the rope where they are readily seen. When checking up on the number of broken wires, the worst broken-up section of the rope should be located by a general inspection.

Fig. 1—Section of a $\frac{5}{8}$-in., 6x19 rope. *A* and *A* are the same strand one rope lay apart

Various rules have been used for determining the number of broken wires, but the one based on one-lay length has much to recommend it, because the size and construction of the rope is taken into consideration. It has been determined by many tests made on ropes in all kinds of service that a careful approximation of the remaining strength based upon one rope lay will be a reliable guide in judging similar ropes when used in the same service.

The length of a lay may be determined by following one strand around one revolution on the rope. It may also be obtained by counting the strands on one side of the rope as in the figure. To do this, mark one strand and count along the rope surface a number of strands

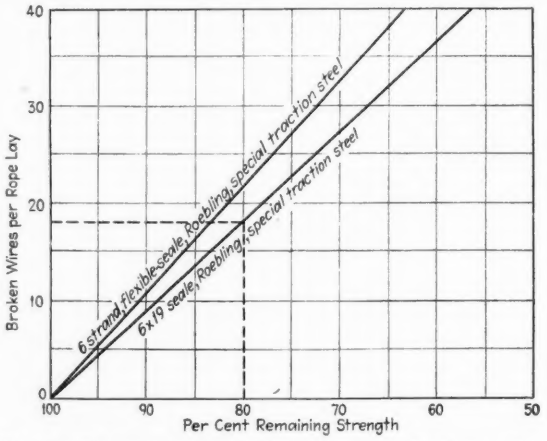


Fig. 2—Per cent of remaining strength, broken wires uniformly distributed in the rope

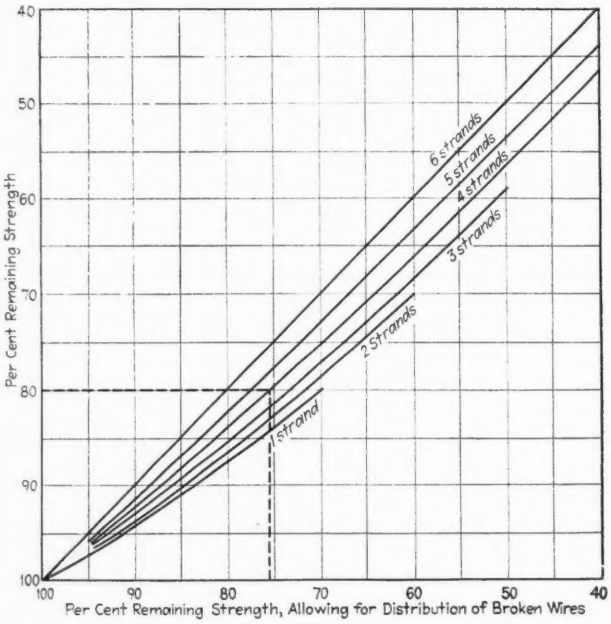


Fig. 3—Per cent remaining strength, allowing for unequal distribution of broken wires

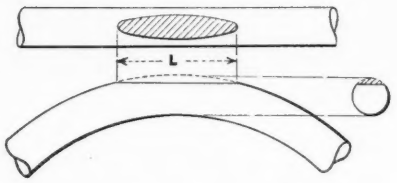
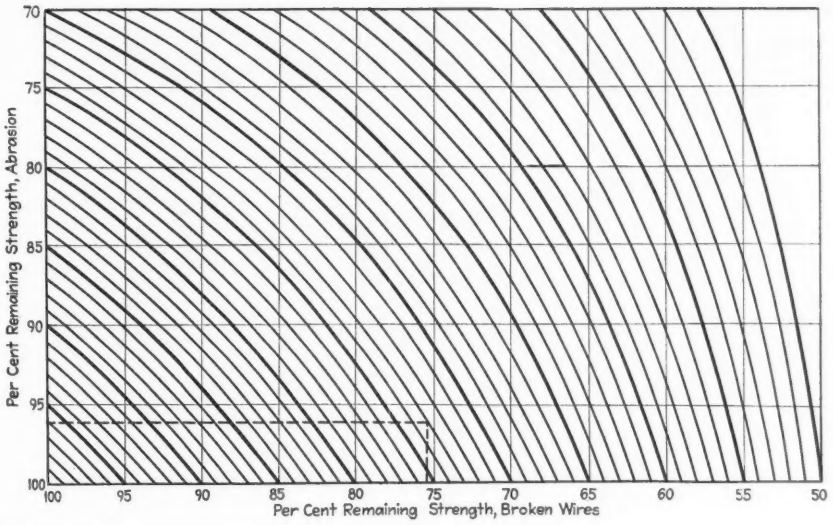
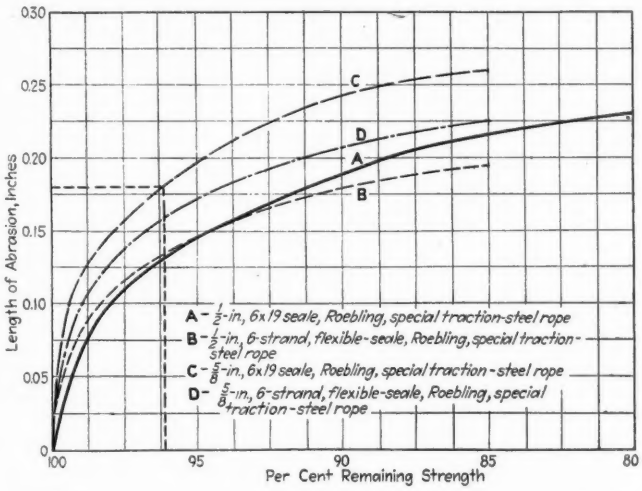


Fig. 4 (Above) — Cross-hatched area shows form abrasion takes on one wire in a strand

Fig. 6 (Right) — Per cent remaining strength when broken wires and abrasion are considered

Fig. 5 (Below) — Per cent remaining strength, considering abrasion only





equal to that in the rope plus one. For example, in Fig. 1 the rope has 6 strands. Mark one strand *A* and, beginning with this strand, count 7 and we are again at strand *A*, as indicated in the figure, the distance between the two marks being the length of one strand lay.

When the worst section of the rope has been located by a general inspection, select the lay length that is in the worst condition and count the number of broken wires in that section. Broken wires in a rope represent a direct loss of metallic cross-sectional area that is reflected in its strength.

The loss of strength due to broken wires is shown by the curves Fig. 2. The right-hand curve gives the per cent of remaining strength in $\frac{1}{2}$-in. and $\frac{5}{8}$-in., 6x19, seale, Roebling special traction-steel rope when the number of broken wires alone in the rope are considered. The wires are assumed to be uniformly distributed among the strands of a rope that has not been subjected to abrasion.

The left-hand curve, Fig. 2, is for $\frac{1}{2}$-in. and $\frac{5}{8}$-in., 6-strand, flexible-seale, Roebling special traction-steel rope for the same conditions applying to the other curve. These curves are straight lines and show that the strength of the rope varies directly as the number of broken wires uniformly distributed in the strands.

The distribution of broken wires in the rope has an influence on its remaining strength. For example, if there were eighteen broken wires in four strands in one lay and the other two strands had no broken wires, the remaining strength of the rope would be less than if the broken wires were equally distributed in the strands.

To take into account the distribution of broken wires, the curves, Fig. 3, are presented. Assume that a $\frac{5}{8}$-in., 6x19, seale, Roebling special traction-steel rope has eighteen broken wires in four strands. If these wires were equally distributed, the rope would still have about 80 per cent of its original strength, as obtained from Fig. 2. Correcting this value in Fig. 3 to allow for the broken wires being in four strands only reduces the remaining strength to 75.5 per cent.

The amount of abrasion, the next factor affecting the strength of a used rope, is not easily determined by inspection. A method has been developed, however, whereby this factor can be evaluated with fair accuracy. Fig. 4 shows that wear on a wire on the outside of a strand takes the form of an ellipse, with its major axis running parallel with the wire. This is caused by the curvature of the wire around the strand and the way it contacts the sheave groove.

Various methods may be used to determine the reduction in metallic cross-section due to abrasion, but in the studies on which this article is based the engineers decided that for regular-lay ropes the major axis *L* of the ellipse was the most satisfactory, all things considered. From measurements of the major axis and the curves, Fig. 5, the reduction in strength of the rope due to abrasion may be determined.

When measuring the major axis of the abrasion ellipse on the wire, it should be carefully determined on several wires in the various strands of the rope lay being checked and the average taken. The curves are for the four types of Roebling ropes indicated, and should not be used for other types.

In the application of the curves, Fig. 5, take the $\frac{5}{8}$-in., 6x19, special traction-steel rope previously under consideration and assume that the average wear on the wires of the worst abraded strand has a major axis 0.18 in. long. Curve *C*, Fig. 5, applies to this type of rope, and the point on this curve corresponding to an abrasion 0.18 in. long on the wire gives a remaining strength of the rope of 96 per cent.

This reduction in strength is due to abrasion alone and must be combined with the remaining strength estimate on the number and distribution of the broken wires. To do this the curves, Fig. 6, have been developed. In the problem under consideration, the remaining strength of the rope when broken wires are considered alone is 75.5 per cent and for abrasion alone 96 per cent. Applying these two values to the curves, Fig. 6, it will be found

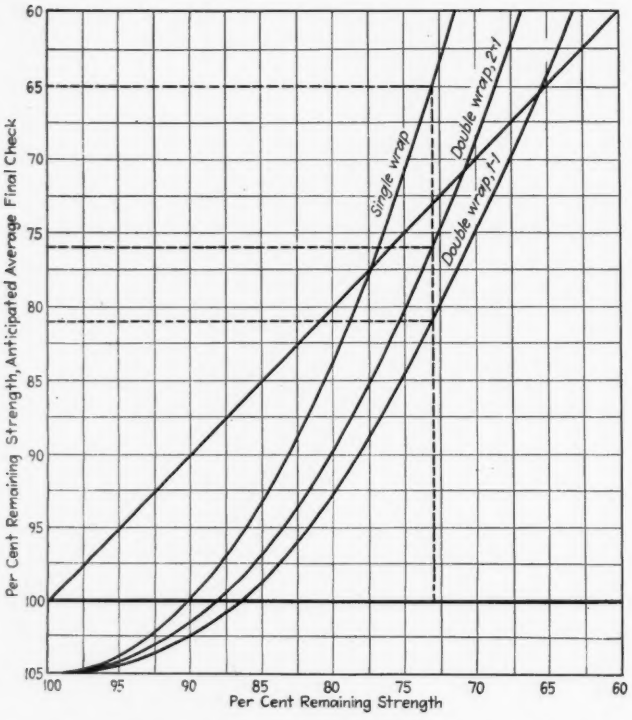


Fig. 7—Per cent remaining strength when broken wires, abrasion and rope service are considered

that their projections meet at a point on the curve for 73 per cent remaining strength. In other words the remaining strength of the rope when broken wires and abrasion are considered is about 73 per cent of the original rated value.

The remaining strength of the rope when broken wires and abrasion are considered must be corrected for service conditions. This is done with the curves, Fig. 7, which have been plotted for three kinds of traction-elevator service. On the horizontal scale of "Per Cent Remaining Strength" find the value of remaining strength 73 per cent and run vertically to intercept the three curves.

Projecting the point of intersection with this curve for a double-wrap 1-to-1 traction elevator to the left-hand scale, we get a value of 81 per cent for the remaining strength of the rope when all factors are considered. If the elevator is a double-wrap, 2-to-1 traction, a value of remaining strength of 76 per cent is obtained. Assuming the ropes to be on a single-wrap traction elevator, the value of remaining strength of the ropes becomes about 65 per cent. In the first two applications, the correction increased the remaining strength of the ropes over that obtained by considering broken wires and abrasion alone, while the third application correction decreased the remaining strength.

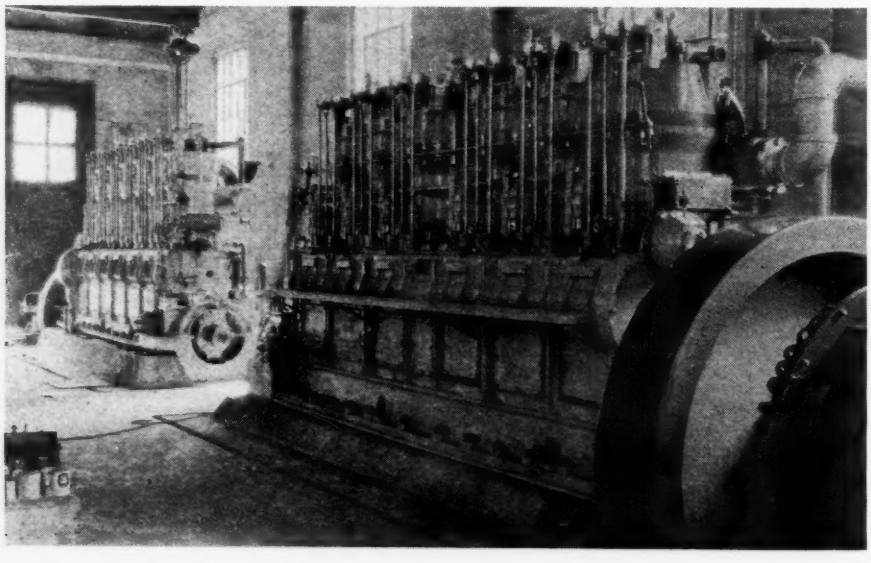
Just why the strength of a rope should increase is not entirely understood, but it is known that for a certain period after a rope is put into service its strength increases. One of the chief factors in this increase is that the different parts of the rope adjust themselves better to equalize the load among them.

Since results of this investigation were made known two years ago, research has been continued. Up to date, the results of this work have shown that the curves in this article give values that are conservative, and when properly applied give a safe value of remaining strength for types of wire ropes for which they were developed.

When the remaining strength of a set of hoist ropes is known, the next problem is to apply this information to determining the safe condition of the rope. One important factor in the safe life of a rope is the rate at which the rope is deteriorating. This can only be determined by a knowledge of the rope's performance gained from previous inspections. One set of ropes, when it starts to fail, may break up quickly, where others may develop broken wires at a slow rate. Obviously, in two sets of ropes of equal remaining strength, but one breaking up more quickly than the other, the one in which broken wires develop at the slowest rate may be expected to have longest remaining safe life.

Work is well under way by the Roebling Company in co-operation with Otis Elevator Co. to obtain data for plotting curves from which the remaining safe life of a rope can be predicted, when its per cent of remaining strength has been calculated by the methods outlined.

Power editors wish to express their thanks to A. J. Morgan, chief engineer, Rope Division, John A. Roebling's Sons Co. and to David Lindquist, chief engineer, Otis Elevator Co., for their assistance in the preparation of this article. Both have devoted a great deal of time and effort to solving the very complicated problem of how to predict the remaining safe life of wire rope in service.

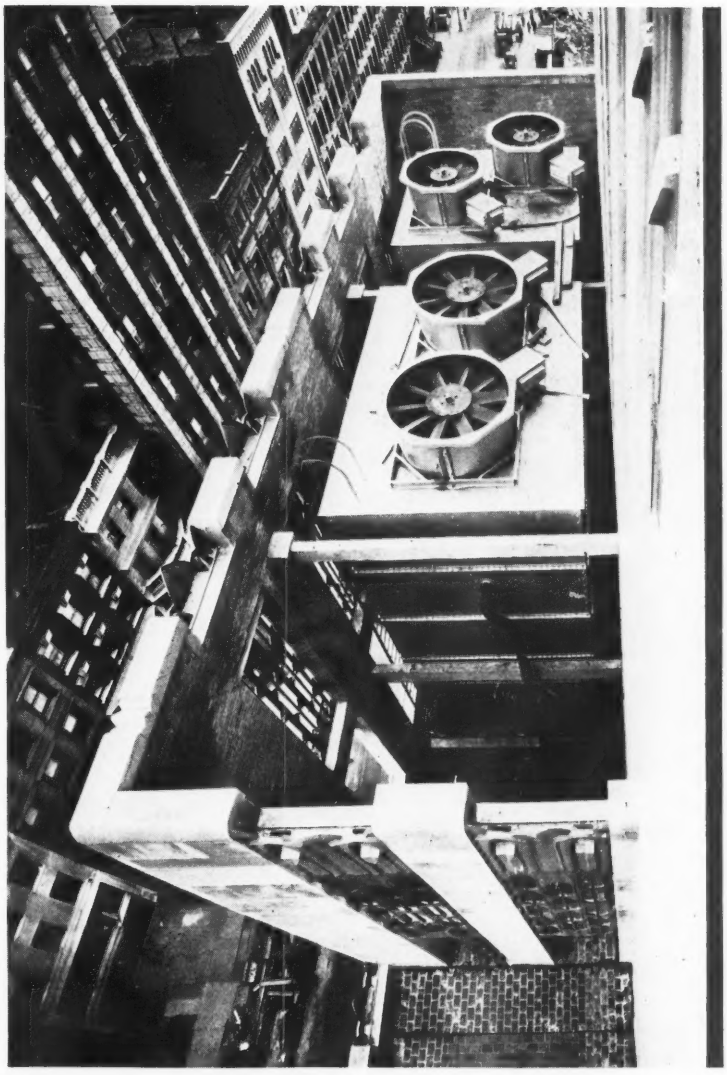


Diesels Drive Park Power Plant

Yakima Park, Government owned and supplying all conveniences, including water and electricity, to its guests, is 55 miles from the nearest power transmission line and over national park land, which may not be disfigured with transmission lines. Hydro generation is impractical because of highly seasonal flow and suspended material in water. Water supply is insufficient for steam. So two Washington Estep diesels have been selected, one 325 hp. and one 440 hp., driving 219- and 250-kva. generators. A 5-kw. gasoline engine set is provided for standby.

CAMOUFLAGED COOLING

Lighter and more compact mechanical-draft cooling towers solve problems of city-building refrigeration and air conditioning. Here are two new New York examples, one masked by architectural walls and grilles, the other hidden by roof monitors



Two induced-draft cooling towers for air-conditioning service in Radio City Music Hall, Rockefeller Center, fitted with gear-driven, 2-stage, disk fans. Concealed behind walls with special grilles for air admission, they cool 615 and 413 g.p.m. Other units on other buildings are similarly concealed

Courtesy The Cooling Tower Co., Inc.

Of the five cooling towers on Macy's roof, two serve the new 1,000-kw. turbine, three the two turbines driving air-conditioning compressors. The first two are rated at 2,700 g.p.m., the others 2,360 g.p.m. Full details in *Power*, May, page 226

Courtesy Foster-Wheeler Corp.

LUBRICATION OF COAL H

DUE to dust contamination a special lubrication problem is presented by the mechanical equipment involved in the conveying of coal from the car to the boiler.

The lubrication of this equipment can perhaps best be divided into three general parts:

1. The lubrication of motive equipment. *(See footnote at end)
2. The lubrication of conveying and handling equipment.
3. The lubrication of preparation equipment, i. e., crushers, pulverizers, mills and blowers, etc.

Lubricants used in equipment included in sections 2 and 3 above should be selected with the following in mind:

Function of the Lubricant

1. It must reduce friction to a minimum.
2. It must exclude dust and dirt from bearing surfaces.
3. It must protect the bearing surface against excessive wear, abrasion, scoring or galling.

Essential Properties of the Lubricant

1. It must be adaptable to the particular type of bearing and lubricating system.
2. It must not corrode equipment and yet must serve as an effective rust preventive.
3. It must be stable over extended shut down periods, intermittent, slow or high speed operation, under light or maximum overload operation.
4. It must resist the erosive action of water.
5. It must have satisfactory load carrying characteristics.
6. It must be economical and have good lasting properties.

As operating conditions and equipment vary, lubrication usually is an individual problem for each plant. Temperatures sometimes are extreme, and dust or water may be present in excessive amounts. Frequently bearings are located at inaccessible points which are stories above or below control floors, and where, if neglected, replacements would be difficult and costly. It is therefore essential that only products of highest quality and proven merit be considered. Grease lubricated bearings should be serviced with a good grade of waterproof lubricant of pressure gun grease consistency or harder. Well refined machine oils of adequately high viscosity and low pour point are recommended for hand oiling, ring oiled bearings and for various types of pin, wick or bottle oilers. For all exposed gears such as on car dumps, sprocket wheels, stokers and screw conveyors, also skip guides for bucket and chain conveyors, shoes, link chain, wire cable, etc., it is desirable to have a heavy lubricant of tenacious character. All should be water resistant, have a high film strength (load carrying capacity) and provide proper viscosity or body requirements at operating temperatures.

Scale bearing points are generally designed to operate dry. They should be frequently examined and kept free from rust. Applications of heavy lubricants to such points tend to build up hard accumulations of dust which may eventually cause excessive wear or retard normal operation of the part.

Special care must be given to all ball and roller bearings not provided with approved dust tight seals. Whenever the lubricant in such points is found contaminated with foreign matter or water, the unit should be flushed out with several applications of kerosene or flushing oil, and fresh lubricant of proper nature for the service and in correct amount, applied.

More and more sealed bearings lubricated thru pressure gun fittings are being used. Belt conveyor rollers equipped with seals that will effectively prevent any infiltration of dust, dirt or water are now available for both oil and grease lubrication. At the same time lubricants that will withstand such service have been developed.

Of lubricants, it may be stated in general that:

1. The use of soap thickened oils or semi fluid greases will materially extend the interval between servicing certain types of bearings with oil.
2. Intermittent oiling requires the use of a product of somewhat higher viscosity than necessary when servicing the same bearing thru a continuous lubricating device.
3. Within limits, more lasting oils are distinctly more economical in spite of probable higher initial cost.

Circulating systems on pulverizers and crushers require an oil of good stability and moderately heavy body. When such equipment is supplied with preheated air the oil operating temperatures may run high. The stability of the oil then becomes increasingly important if sludging and frequent oil changes are to be avoided. Where air temperatures are raised above normal to secure increased efficiency, heavier bodied oils may be necessary to furnish ample bearing protection. Such oils may be too heavy for proper circulation upon starting after shut downs and, means must be provided for warming the oil before starting, or an oil cooler may be installed and the use of the lighter bodied oil continued. The latter method is preferred since it will assist in keeping the operating temperatures of the bearings within safe limits. The lighter oil also eliminates the danger of insufficient lubrication caused by sluggish oil circulation on starting.

A definite schedule of daily or more frequent lubrication, if necessary, secures best results. One or more individuals should be assigned to the duty and thereby assume all responsibility for equipment inspection and condition. The recommendations of an experienced lubrication engineer may be advantageously followed in the selecting of products. Such a program if followed will effectively lower repair costs and materially extend the period of efficient operation.

(*)—Note:

In previously issued monographs the subject of motive power lubrication has been presented.

Monograph No. 3 — Electric Motor Lubrication
Monograph No. 6 — The Lubrication of Speed Reducers
Monograph No. 10 — Air Compressor Cylinder Lubrication

1322

STANDARD OIL COMPANY
(INDIANA)
910 S. Michigan Ave. Chicago, Illinois

HANDLING EQUIPMENT

Variety of Equipment and Conditions Complicates the Lubrication Problem

There are dozens of different methods of handling coal from car to boiler. The problem of what kind of lubricant is best for this equipment or that machine is sometimes a difficult one. Correct lubrication of coal handling equipment depends on so many different things that no general rule can very well be given. The safest practice is to place the job in the hands of Standard Oil Company (Indiana) Lubrication Engineers.

These engineers lend their services without charge to help you find the best lubrication methods to fit your equipment and your operating conditions. They have given their services to many plants throughout the middle west and in some cases have made improvements in lubrication methods that have caused startling savings in lubrication costs.

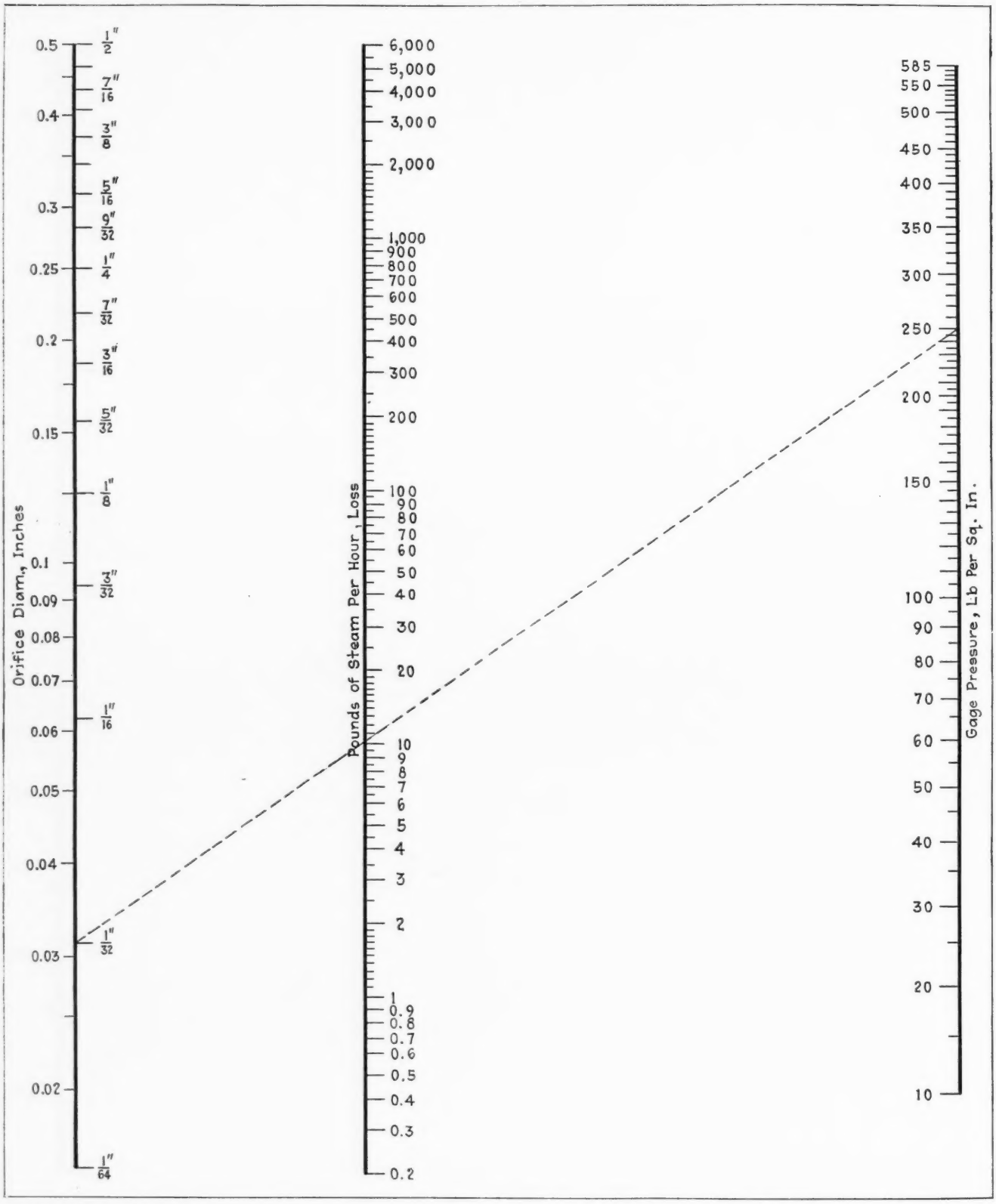
If you have lubrication problems in your power plant needing study, we will gladly have our engineers undertake the work. They will give you thoroughly reliable and scientific advice on the lubrication methods and type and quality of lubricants which will give the most effective results in your plant at the least total cost of lubrication. A request made to any of our offices will bring one of these men to see you.

Number 14

STEAM LEAKAGE CHART

• SMALL steam leaks are all too often neglected and allowed to continue, sometimes for a year, before any attempt at repair is made. Yet during one year, the steam lost through a $\frac{1}{32}$-in. diameter leak in a 250-lb. main would be 89,000 lb.

From this chart can be easily determined the dry saturated steam lost through leaks to the atmosphere. It is based on Grashof's formula. For wet steam, divide the hourly steam loss found with this chart by the square root of the quality; for superheated steam, divide the steam flow by $(1 + 0.00065\ T)$ where T is the number of degrees of superheat.



By E. Cowan, *Industrial Consulting Engineer*

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POWER PLANTS IN PALESTINE

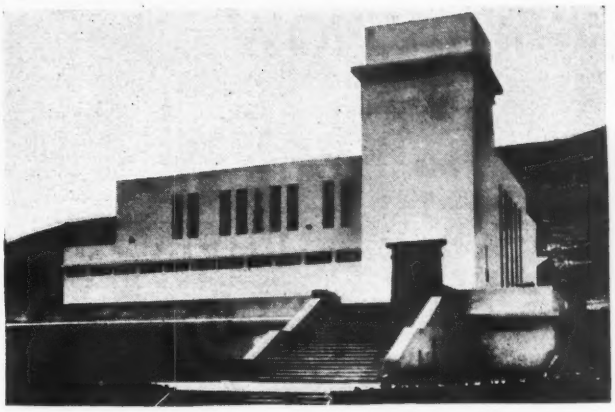
By WILLIAM SCHACK

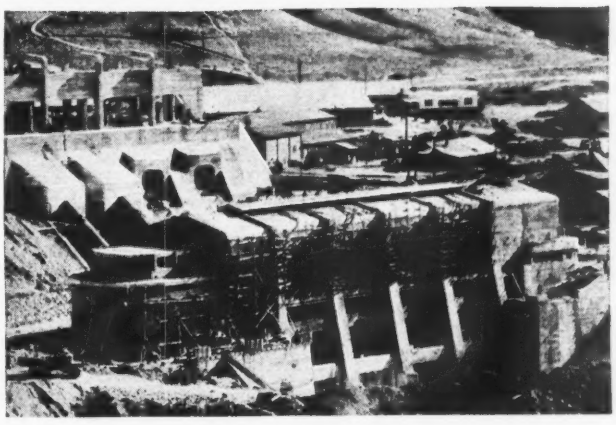
TEN years ago, Palestine had no power plants; today they have become almost essential in the industrial and agricultural life of the land. Of course the figures, in comparison with our own intensive power development, are small, but it must be remembered that Palestine is no larger than Rhode Island, that its economy was unchanged for 2,000 yr. until after the great War, and that in 1913, it boasted of one automobile.

The Zionist engineer, Pinhas Rutenberg, realized more than ten years ago that cheap electric power was an important requisite to development. The Jordan watercourse was the only source. Rising in Mt. Hermon (3,085 ft.) it passes through Lake Huleh (10 ft.), Lake Tiberias (—615 ft.) and empties into the Dead Sea, 1,230 ft. below sea level. The two lakes were made into reservoirs and the Yarmuk, a tributary of the Jordan, was diverted to increase the water supply, since the Jordan has good flow only during the rainy season. Finally, after much political pressure, a concession was granted in 1921, but work was not begun until 1927 under supervision of Rudolph Pfister. The first units were built at Tel-Or, south of Tiberias, where a drop of 154 ft. occurs in less than 6 mi. Here, early last year, the first two of four 8,500-hp. units were completed. But meanwhile, Rutenberg built fuel stations at Haifa, Tel-Aviv and Tiberias as load builders, to be used as standby units when the hydraulic plant was finished. Jaffa, adjacent to Tel-Aviv, got its first power late in 1923, despite much agitation from the Arab portion of the populace. (Incidentally, the power house at Haifa was used as a fortress by the Jews during the riots of 1929.)

How avidly the population took to electricity may be gathered from these consumption figures: Tel-Aviv, with installed capacity of 1,000 hp., sold 500,000 kw.-hr. in 1924, but in 1930, with 4,000 hp., it sold 3,400,000. Between 1931 and 1932, consumption rose from 5,352,000 to 8,442,791 kw.-hr., an increase of 57.7 per cent. In 1932, consumption reached 16,000,000 kw.-hr., an increase of nearly another hundred per cent.

This last increase has been since inauguration of the Jordan units and has cut the rate from 50 mils (nearly 25 cents per kw.-hr. at the 1931 exchange rate) to 30 mils, for domestic use. For power use, the rate is 15 mils, for irrigation 5-10. It has been estimated that 43 per cent of the demand is industrial, chiefly small units, and 33 per cent agricultural, chiefly irrigation of orange groves.





Haifa (at top) and Tiberias are two examples of the "functional" architecture of Palestine power plants. The Jordan gate of the Rutenberg Works at Tel-Or and the completed Jordan Dam are shown in the lower protographs

WHY and HOW

Compressed Air Should Be Cleaned

Both economic and operating factors prove that compressed air should be cleaned. Here are given the reasons for cleaning air, together with descriptions of commercial units that remove moisture, oil and dirt

DELIVERING compressed air free of dirt, moisture and oil is a problem. The solution begins before the air enters the compressor. Hydraulic-type rotary compressors will wash the air while it is being compressed and deliver it clean, but this type is limited to pressures of about 30 lb. and less. With other types of compressors, rotary or reciprocating, a large part of the dirt entering the compressor with the air is carried out of the discharge. This dirt in the air has many deleterious effects, as outlined in "Clean Air Reduces Operating Costs," in the September number of *Power*. To eliminate these objections and to simplify the problem of supplying clean air, all air compressors should be equipped with air filters.

If the free air is effectively cleaned before it enters the compressor, there usually remains only the problem of removing moisture and oil from the compressed air. Air entering a compressor is frequently almost saturated with moisture, and in one day's operation large quantities of water vapor are carried into the compressor.

The amount of water vapor that can be present at a given temperature in a given space is independent of other gases that may be in that space and the pressure of the gases. For example, 1,000 cu.ft. of free air at 70 deg. F. and 100 per cent relative humidity contains 0.93 lb. of water vapor. If this air is compressed to 100 lb. per sq.in. gage pressure and cooled to its original temperature it will then be saturated with water vapor but will contain only 0.15 lb. of moisture, because the volume of air has been reduced from 1,000 to 128 cu.ft. The difference in the weight of water vapor under the two conditions, 0.93—0.15=0.78 lb., is precipitated from the air in the form of water.

A 2,000-cu.ft. per min. compressor at rated capacity, operating 8 hr. per day, handling free air of 80 per cent relative humidity, will pass through it each day about 900 lb. of water vapor. If the air is compressed to 100 lb. gage and cooled to its original temperature, only about 16 per cent of the vapor will remain in the air so that about 750 lb. will be deposited as water in the different parts of the compressed air system, such as intercoolers, aftercoolers, receivers and pipe lines. There are also the possibilities of the water content of the compressed air being increased because of leaks in intercoolers and aftercoolers.

During compression, the temperature of the air rises so fast that the water vapor in the air does not condense but becomes superheated. If the air could be used in this form, the moisture would do no harm in many applications, but generally the air is stored in a receiver, then is transported through long pipes where the moisture will condense. Unless the water is removed, it will collect in the receiver or be carried along in the pipe line and into the devices where it is used.

If air is used in tools, locomotives and other equipment without reheating, the expansion will produce a suf-

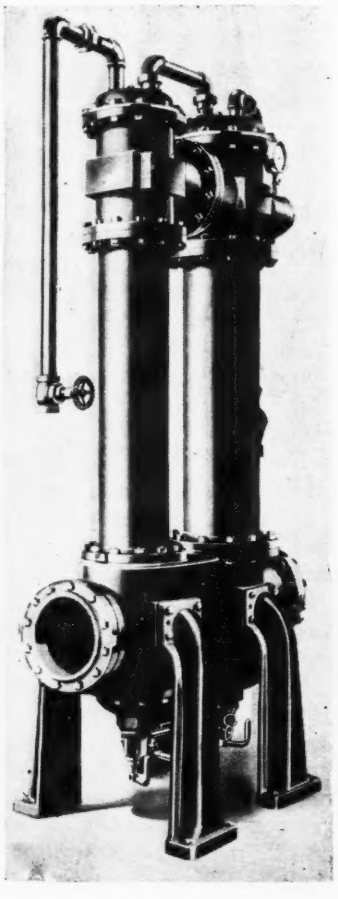
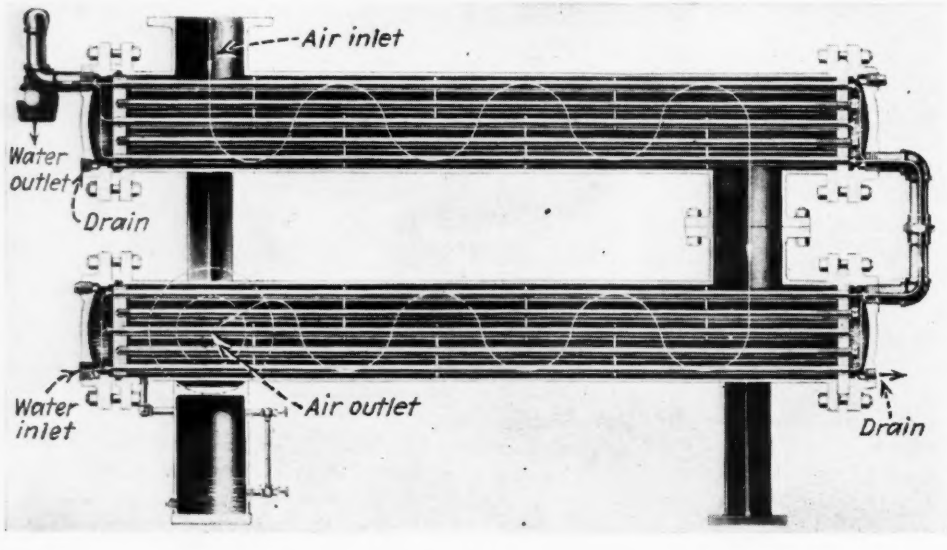


Fig. 2 (Right) — Ingersoll-Rand vertical-type aftercooler

Fig. 1 (Below)—Cross-section through a Worthington horizontal-type aftercooler



ficiently low temperature to cause the moisture to be deposited as frost on the valves and passages and thus to interfere with operation.

When air carries water into tools and other devices that require lubrication, the water washes away the lubricant and causes excessive wear and maintenance costs. Because of inadequate lubrication, the equipment operates unsatisfactorily and its efficiency is decreased. Water in compressed air also causes water hammer in pipe lines and reduces their carrying capacity by collecting at low points. It may freeze and burst the pipe in cold weather.

If the air passes directly from the compressor to the receiver and then to the pipe line, expansion and contraction of the pipe may cause leaky joints. When the line is in service, it will have a temperature approaching that of the air leaving the compressor; when not in use its temperature will be that of the outside air.

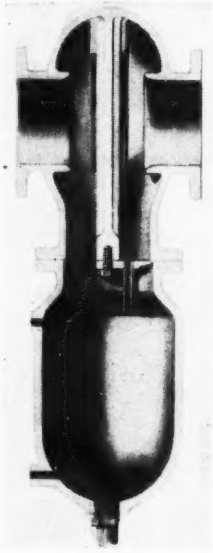


Fig. 3 (Left) — Cochrane separator for cleaning compressed air

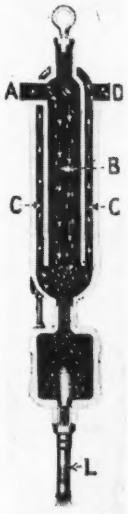


Fig. 4 (Right)—Cross-section through a Swendeman compressed-air separator

Air as it passes through the compressor takes up more or less oil in the form of vapor and carries it out of the discharge. The oil, if not removed, is carried into pipe lines and comes in contact with gaskets and the inside of hose lines where it may cause serious damage to these parts. Oil is also objectionable in compressed air for the spraying of paints, the cleaning of electrical insulation and for agitating milk and other solutions.

On medium- and large-size compressed air installations the place to begin removing water and oil from the air is at the compressor, by passing it through an aftercooler. A Worthington aftercooler consists of a nest of tubes expanded into two headers and supported inside a steel shell, Fig. 1. Cold water passes through the tubes while the compressed air flows over them, as indicated by the arrows. Water and oil vapor that condenses in the aftercooler flows to a receptacle at its cold end and is drained off automatically by a trap or is taken care of manually by opening a valve at intervals. Aftercoolers are available in sizes of 100 to 10,500 cu.ft. per min. Both coil and tube designs are used, depending upon the size required, and they are available in either horizontal or vertical types. Fig 2. shows an Ingersoll-Rand vertical aftercooler.

The amount of vapor that can be removed by an aftercooler is limited by the temperature of and the amount of cooling water used. The temperature of the

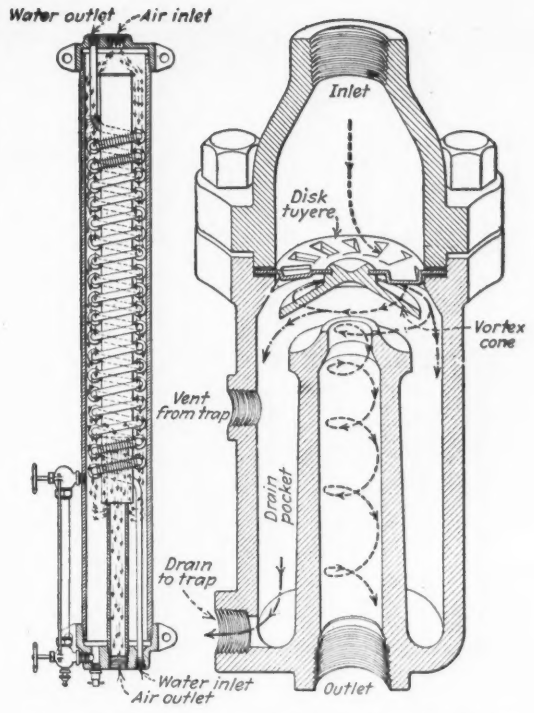


Fig. 5 (Left)—Cross-section through a Spraco oil- and water-vapor condenser. Fig. 6 (Right)—Cross-section through a Centrifix compressed air cleaner

water will vary with location and the seasons of the year. In any event it is not economically possible to remove sufficient moisture from the air by cooling to insure dry air at all times. As soon as the air, for any reason, is cooled below the temperature at which it leaves the aftercooler, it will begin to precipitate moisture in the receiver and pipe lines.

Although in summer the temperature under which the air is used may not go below that obtaining when it leaves the aftercooler, in the winter the temperature around the receiver and pipe lines may be below freezing. Scale and other dirt may accumulate inside pipe lines and other parts of compressed-air equipment. This dirt becomes free and is carried through the compressed-air system, and may be objectionable.

To remove the dirt and moisture that is not taken out by the intercoolers and aftercoolers, a separator must be inserted out on the lines where the air is used. The first precaution is to design and install the pipe lines properly. All air piping systems should be uniformly graded in the direction of flow insofar as possible and all low points should be properly drained. Sags and low points should be equipped with separators to drain off any accumulation of moisture. If low points in the lines are not properly drained, water will accumulate and restrict the flow, cause an unnecessary loss of pressure, may freeze in cold weather and may burst the pipe.

There are several types of separators that may be installed on air lines to remove water, oil and dirt. One of these, the Spraco, Fig. 5, is similar to an aftercooler but also causes an abrupt change in air flow to assist in cleaning the air by centrifugal action. The air in passing through the separator goes over a cooling coil of finned tubing, through which passes a small quantity of water to insure a sufficient temperature reduction to cause the vapor to condense out of the air. The sharp change of direction made by the air as it enters the central tube insures that the condensed vapors and dirt

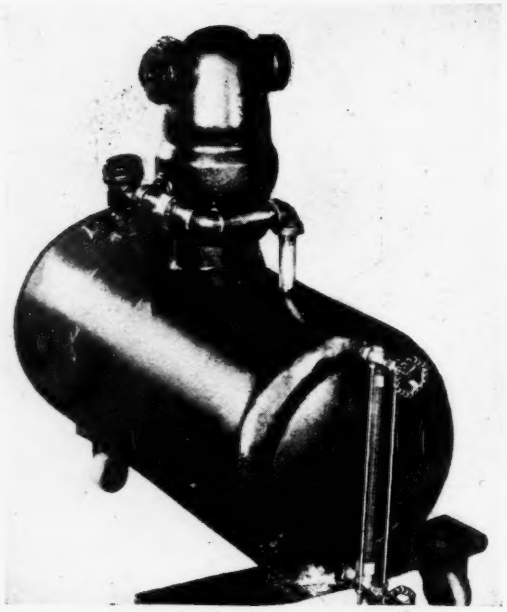


Fig. 7—Hagan separator mounted on a portable oil- and water-receiving tank

will be precipitated to the bottom of the separator where they may be drained off at intervals. This equipment is limited in its use to points at which cooling water is available and the temperature does not go below freezing.

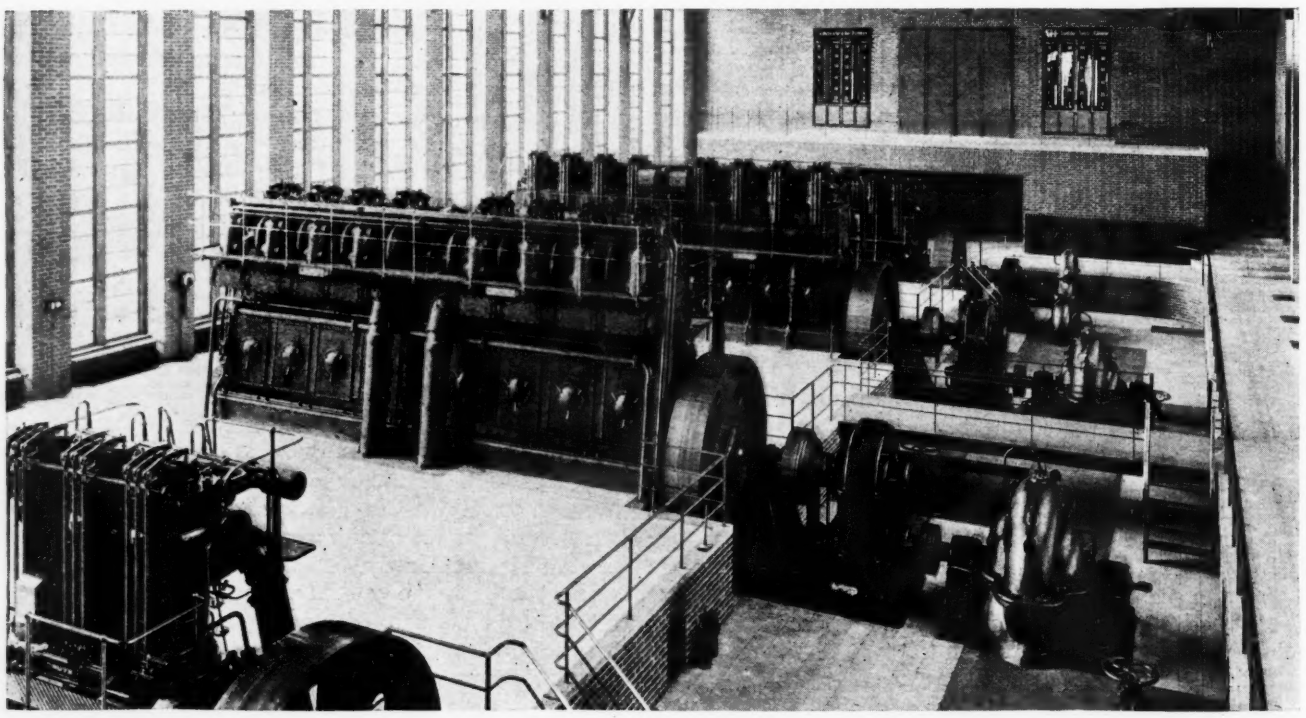
Other types of separators operate on a purely mechanical principle. In the Cochrane separator, Fig 3, the air current impinges upon a single ribbed solid baffle from whence it is deflected through two side openings around the baffle. When the air current comes in contact with the baffle, the suspended particles of water, oil and solid matter strike against it. The vertical ribs on the baffle surface prevent the air current from scrubbing off the water and oil and it flows down into the receiving well. From the well the water may be trapped off or taken care of manually by opening a drain valve at intervals.

Fig. 4 shows a cross-section of a Swendeman automatic separator, built by the Leavitt Machine Company. Air enters at *A* and passes into the expansion chamber *B*. Expanding the air lowers its temperature and precipitates out the water and oil. At the lower end of the expansion chamber the air makes a 180-deg. turn and passes up the annular chamber *C* to the outlet opening. The condensed water and oil vapors and the solid matter go downward into the eliminator, from which they are expelled through vent *L*.

In the Centrifix compressed air cleaner, Fig. 6, the air comes into the top of the separator and passes through a disk tuyere which directs it in a spiral whirling motion. Water and other impurities, being many times heavier than air, are thrown to the outer drain pocket while the clean air passes out through the central standpipe. A core-shaped vortex breaker is placed beneath the disk tuyere to eliminate the possibility of impurities entering the central vortex and again being picked up by the air. Liquid precipitated from the air is drained off automatically through a trap.

Fig. 7 is a portable compressed-air cleaning unit, consisting of a Hagan Corporation centrifugal-type separator mounted on a water and oil receiving tank. This unit can be easily moved to any location and connected into the air line where air is to be used.

There are several other types of compressed-air cleaners available, but those described give general principles involved. Other companies contributing information for this article are the American Air Filter Co.; New Jersey Meter Co.; The Elliott Co.; W. H. Nicholson & Co.; Pangborn Corporation; The Direct Separator Co., Inc.; Strong, Carlisle & Hammond Co.; Wright Austin Co.; The Swartwout Co.; Tryco Products, Inc.; Advance Engineering Co.; Ruemelin Manufacturing Co.; Kieley & Mueller, Inc.



Cologne (Germany) waterworks has two 1,200-hp. diesels, two 270-hp. Special gage boards show pump and engine data

BIMETALLIC SNAPPER DISK Protects Motors

By JAMES DeKIEP
Industrial Motor Engineer, Westinghouse Electric & Mfg. Co.

OVERLOAD protective devices in a motor control circuit keep the windings from attaining a temperature injurious to the insulation. Any temperature below 105 deg. C. causes no appreciable harm to class A insulation, according to A.I.E.E. Standards, while temperatures above are apt to char the insulation and cause rapid deterioration. Thus if the motor protection assures that the insulation temperature remains below 105 deg., the insulation will last indefinitely.

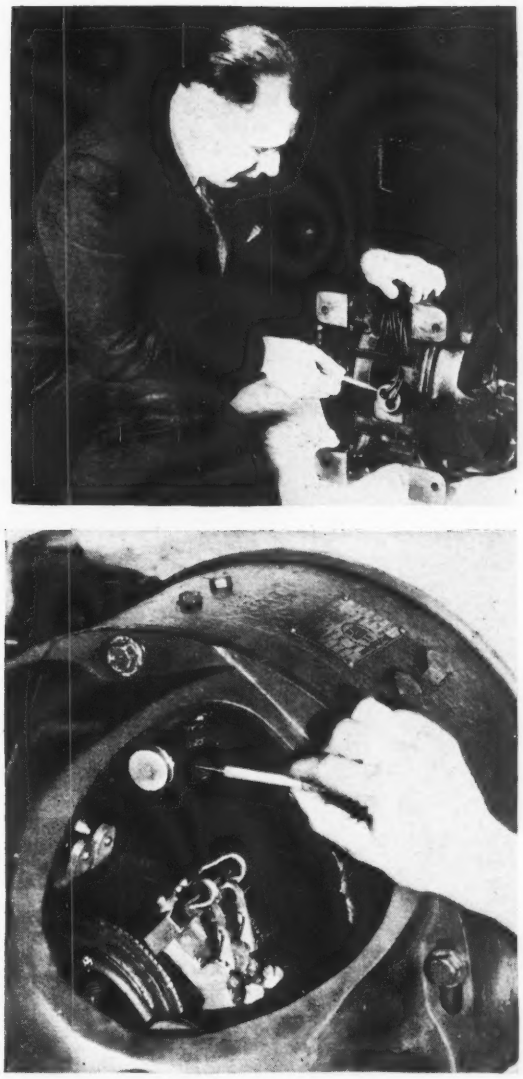
Although the most dependable type of protection is one actuated directly by the temperature of the motor windings, protective devices in general have been operated by current input to the motor. Under ordinary overload conditions, this protection is adequate, but any increase in temperature due to some cause other than input is not protected against by these relays. Such a condition might be caused by dirt collecting around the motor, shutting off most of the ventilation and causing the windings to attain a dangerous temperature without an increase in input.

Another such condition can be encountered if the motor is started and stopped frequently. If starting frequency is increased, motor temperature is likely to rise to an injurious point, even though peak current values have not increased. The heater in the control circuit cannot take care of this condition, because its heating and cooling curve cannot duplicate that of the motor.

A third case is when the starting duty of the motor is very heavy. In applications where it is necessary to accelerate high-inertia loads, the motor is subjected to from 250 to 400 per cent full-load current over an appreciable time. This condition requires that the external protective devices be so adjusted that the motor can take the heavy current without being tripped off the line. With the external relay set to permit the heavy starting-current inrush, it does not protect the motor under light and medium sustained overloads.

A small thermostat having little thermal capacity gives the desired protection. It follows the temperature of the motor and is capable of interrupting the current carried in control circuits. The thermostat is installed in intimate contact with active parts of the motor and set to operate when the temperature approaches the danger point.

The bimetal disk is well suited for this application, acting with a quick snapping action at its opening and resetting temperatures. The disk can be adjusted to operate within 1-deg. or 2-deg. range.



Top—On open squirrel-cage motors, stator laminations are drilled and tapped for mounting the protective thermostat. Below—On direct-current motors, the thermostat is mounted on the interpole winding

Such motor protection can be utilized in several ways. When the thermostat operates, it can disconnect the motor from the line or flash a warning to the operator. If the thermostat is connected into the control circuit so that the motor is automatically shut down when it reaches a dangerous temperature, the motor cannot be restarted until the windings have cooled sufficiently to allow the thermostat to reach its resetting temperature, approximately 12 deg. below that of opening. While the motor is tripped off the line the cause of the abnormal heating may be investigated and corrected.

By using a signal instead of removing the motor from the line, shutting down the motor during a cycle of operation is avoided. If the application is a starting or reversing cycle, it is then possible to decrease frequency until the motor has cooled to a safe temperature. Use of a warning has the added advantage of natural ventilation during the cooling period.

The combination of a thermostat in the motor and a thermal-relay in the control insures ideal motor protection. The thermostat protects against running overloads, the thermal relay against high overloads during starting.

DIESEL-FIRED BOILERS

TYPES • SIZES • USES

Last of the series of articles on utilization of diesel engine waste-heat, this article describes and illustrates commercial types of waste-heat boilers and water heaters for diesel service. Previous articles appeared in *Power* in June, July and August of this year

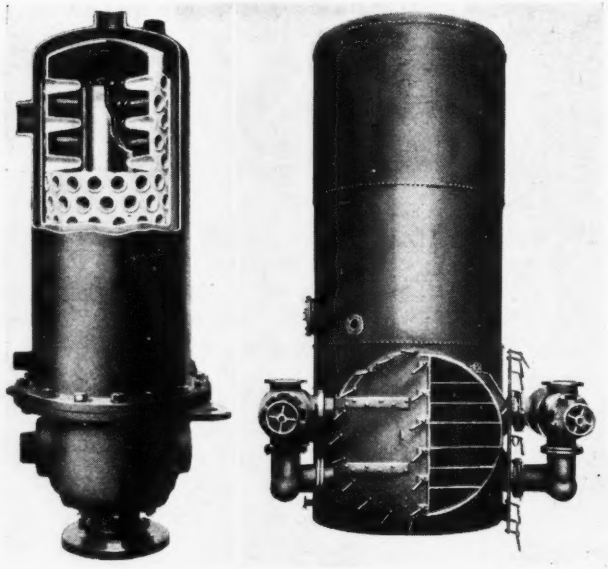


Fig. 1 (Left)—Edge Moor-Clarkson waste-heat boiler, upright type. Fig. 2—M.A.N. water heater, with storage tank, designed for two 700-b.hp. diesels

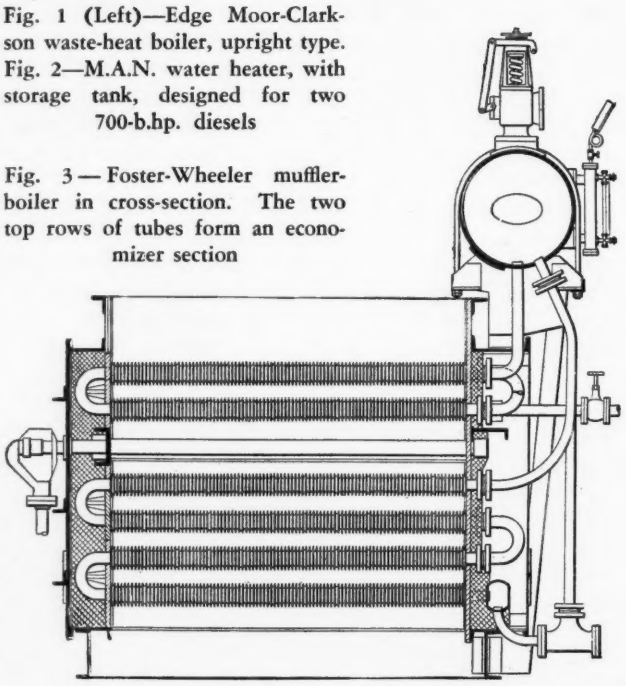


Fig. 3 — Foster-Wheeler muffler-boiler in cross-section. The two top rows of tubes form an economizer section

GRANTED that the diesel is one of the most efficient appliances for converting heat into useful work, even the best designed diesel can use only one-third of the heat in the fuel, the remaining two-thirds being about equally divided between the exhaust and the jacket water. The jacket water, to perform its primary purpose of cooling the engine, must be kept at fairly low temperature. Thus it is of little primary value as a source of heat, although it may be used to supplement the heat recovery when the major recovery is made from the waste gases.

If the recovered heat is to be used only for preheating fuel or for heating air, a simple home-made heat exchanger, or one of the common commercial units, will function satisfactorily. If, however, steam or hot water at high temperature is to be generated a waste-heat boiler is more satisfactory. Either a heater or boiler, for this service, must be able to withstand sudden changes in temperature, must be able to operate continuously, intermittently, or dry with a minimum of attention, must avoid creation of undue back pressure, must allow easy removal of soot and scale, and should operate satisfactorily as a muffler whether operating filled with water or empty.

Several American waste heat boilers are modifications of European units, since the utilization of waste heat was given much earlier consideration there due to the higher cost of fuel and the economic conditions. The Edge Moor-Clarkson boiler is an example. Designed originally by Thomas Clarkson of England, it has been modified by Edge Moor Iron Company to conform to the requirements of American laws and the A.S.M.E. Boiler Code. for stationary installations. Fig. 1 shows a typical arrangement. The boiler is essentially two cylinders, the inner having rows of thimble-shaped tubes extending inward toward the center of the unit. A cylindrical baffle within the tubes brings in the waste gases, which then pass downward over the thimble tubes and out. Such a unit can be designed either to rest on a base as shown, or to be suspended from the top. Gases exhausting from the engine may be passed through the unit in several ways. They may enter at top or bottom and flow through it once or twice, depending upon the arrangement of the central baffle and exit at either end as desired. If flow is to be straight through the unit, the central baffle is closed and the dome-shaped deflector is removed to force the gases to pass around the thimble tubes in passing through.

If the unit is operated as a water heater, feed water enters the bottom of the water space and flows upward from one row of tubes to the next as it is heated. If operated as a steam generator, feed water is introduced at a point near the top row of tubes outside the cylindrical baffle between the two cylinders. Because of its greater density, the water flows to the bottom of the

boiler, around and under the water baffle, then upward past the tubes.

These boilers also serve as effective silencers. Further, since the tubes are fastened at one end only, expansion and contraction can take place without damage to the joints. This, coupled with the fact that diesel exhaust temperatures are comparatively low, permits the unit to be operated safely dry. Sizes range from units for 40-hp., 2-cycle engines up to 1,600-hp., 4-cycle engines. Units are also available which permit auxiliary firing when the engines are not running.

Recognizing that, due to varying steam demand, standard boilers would not operate at greatest efficiency, Foster-Wheeler Corp. has designed a boiler (Fig. 3) from which the steam production may be varied although the heat supply is constant. This is done by operating the unit as a flash boiler, feeding only sufficient water to generate the required quantity of steam. The unit is also designed to permit independent firing by an oil burner or other heat source. A cross-section of a cross-drum horizontal, water-tube muffler boiler is shown. The two top rows of heating tubes form an economizer section, feed water passing through them in series before entering the boiler drum. Tubes are expanded into the steel

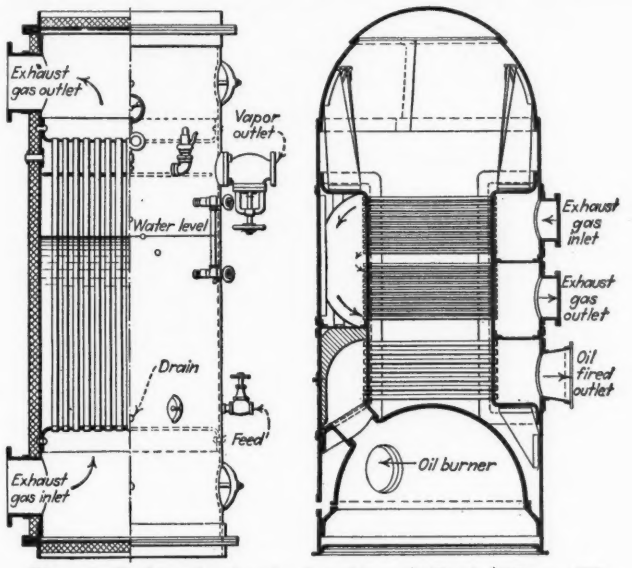


Fig. 4 (Left)—Sectional elevation of Davis "Paracoil" exhaust-gas generator. Fig. 5—Cochrane composite oil and exhaust gas-fired boiler

tube sheet at right, but are free to expand at left. As shown, the steam-generating surface is made up of U-bend elements placed horizontally across the gas passage. These U-bends consist of seamless steel tubing, upon the straight runs of which are shrunk cast-iron gilled ring castings, reamed to size and fitted with male and female end joints to cover the steel tube and prevent corrosion. An iron covering cast directly upon the return-bend portions protects the bends against corrosion, while the ring castings provide six times as much heat-absorbing surface per lineal foot as is presented by a 2-in. bare tube. A recent important installation of Foster-Wheeler units is at the municipal plant of the City of Vernon, Calif., largest plant in the United States.

A fire-tube type boiler, Fig. 4, designed especially for use with the low-temperature waste gases of the diesel, is supplied by Davis Engineering Corporation and is known as the "Paracoil" unit. The unit can be run dry and can provide either hot water or steam. Exhaust gases enter at the bottom of the vertical, insulated unit and pass upward through vertical tubes. In common with other boilers of this type, this unit can handle exhaust from one or several engines. Approximate steam generation, in lb. per hr. per engine b.hp. is, for 4-cycle engines:

Exhaust Gas Temp., Deg. F.	Steam from and at 10 lb.	30 lb.	50 lb.
550	0.64	0.57	0.53
600	0.70	0.64	0.59
700	0.88	0.84	0.80
For 2-cycle engines:			
500	0.81	0.71	0.65
550	0.90	0.80	0.74
600	0.98	0.89	0.83

Shell and heads of this boiler are flanged steel, with circumferential seams riveted. Tubes are seamless drawn steel rolled into tube headers. Gas chambers are provided with nozzles for receiving and discharging gases and fitted with bolted cover plates removable for cleaning or replacing tubes. Construction is in accordance with the A.S.M.E. Code and standard design for 125 lb. per sq.in. working pressure. Sizes are available for engines from 47 hp. 2-cycle units to 1,860-hp., 4-cycle engines.

Other American suppliers of waste-heat boilers and auxiliary equipment include Henry Vogt Machine Co., Union Iron Works, and Babcock & Wilcox. Henry Vogt Machine Co. supplies modified standard boilers for waste-heat use, including cross-drum or vertical-tube units. Union Iron Works makes its units in the standard 2-drum vertical bent-tube design as well as the straight-tube long-drum and cross-drum designs in water-tube boilers. That company also makes a special design double-drum 2-pass fire-tube boiler for this service.

The Cochrane exhaust-heat boiler, an English unit, is normally a water heater. In its usual form, it comprises a horizontal shell with a double pass of fire tubes. In another form it is a vertical shell with horizontal tubes, as shown in Fig. 5.

Extensive use has been made in Europe of waste-heat units for gas engines and large internal-combustion engine installations. Therefore, most foreign engine bulders, notably German manufacturers, either supply a complete line of waste heat equipment or have an arrangement with a boiler manufacturer who supplies the line for them. Deutsche Werft A.G., of Hamburg, for example, supplies Allgemeine Electricitats Gesellschaft,

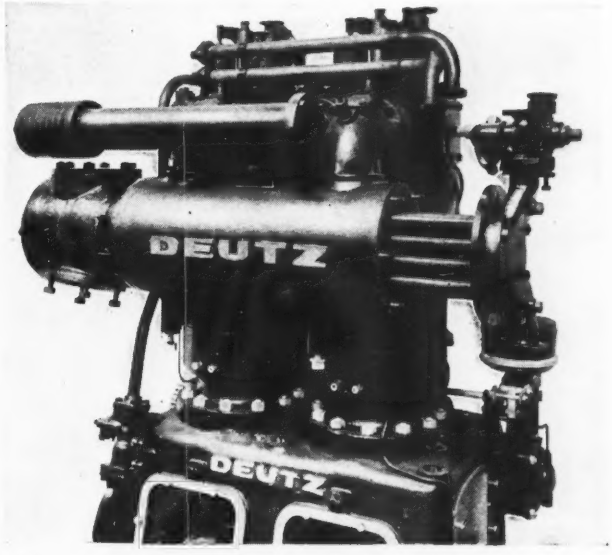


Fig. 6—Deutz waste-heat boiler as an integral part of a 100-hp. diesel. Both jacket-water and exhaust-gas heat are utilized

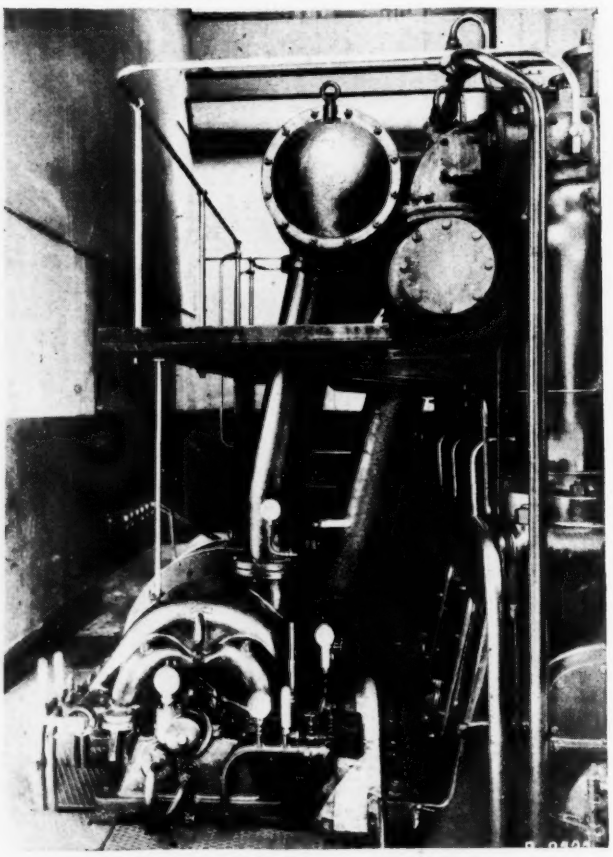
better known as A.E.G., with waste heat boiler equipment.

Humboldt Deutzmotoren, A. G. of Cologne-Deutz has an unusual unit for utilizing waste heat, consisting of a small waste-heat boiler mounted directly on the engine as an integral part. With this unit, Fig. 6, the manufacturer claims to increase thermal efficiency from 38 per cent to 80 per cent and to recover the cost in less than 800 hours of service. The unit, rather than being the familiar gas-tube type, is a water-tube boiler, water-jacketed, which can be converted if desired to run dry or to operate at any desired rate up to its capacity. The unit can be operated in conjunction with any standard low-pressure warm water heating system as well as with low- and medium-pressure steam systems. Illustrated is a 100-hp. unit which utilizes heat in both jacket water and exhaust gases, producing hot water.

M.A.N. Company has designed an entire line of waste-heat recuperators, varying from hot-water heaters through air heaters to waste heat boilers. These are of the horizontal or vertical fire-tube type. Illustrated in Fig. 2 is a water heater operating from two 700-hp. diesels. The horizontal boiler is built into the bottom of a storage tank, thus combining the boiler with an essential hot-water auxiliary. Units can be provided with fixed or removable tubes, or in the case of air heaters as sectional units, according to floor space and service requirements.

With this concluding article of the series, it may be desirable to give a few additional installations where waste heat is being utilized, then to summarize ways in which it may be used.

A familiar method of exhaust heat utilization in Europe is the use of a rotary blower driven by gas turbine for supercharging 4-cycle engines. This Deutz-Buechi-Brown Boveri unit supercharges a 600-hp. engine to deliver 780 hp., increasing power produced by 30 per cent



The M.V. *City of New Orleans,* recently converted from steam to diesel, has 3,720 hp. engines, with waste-heat boilers. Steam is generated at 32 lb.; water enters the boiler at 75 deg. The 550-deg. exhaust gases drop to 375 in passing through the boiler. Exhaust gases average 80,000 lb. per hr., and water fed, 2,086 lb.

Many pipe-line diesels make use of waste heat to distill water for their closed cooling systems, or to preheat lower-grade fuels. Hale Flour Mills, Ionia, Mich., uses engine exhaust for heating water for the mill heating system. Canadian National Railways has diesel locomotive 9,000 fitted up with a waste-heat boiler. Jacket water and exhaust from the 1,200-hp. Westinghouse diesel installed provides steam for heating and cooking, with an automatic oil-fired boiler as standby when the engine is down.

Of course, utilization of waste heat is not limited to the diesel. Gas-engine stations have made use of waste heat for years—principally because there is more waste heat available for reclaiming. Waste heat from gasoline engines and compressors can likewise be used. Jaite Co., Wilmington, Calif., takes jacket water from its 25-hp. compressor for building hot water and heating. The engineer owner of a large roadhouse near Madison, Wis., some years ago rigged up a 30-hp. gasoline engine with a low-compression head and automatic room-temperature-controlled starting and stopping equipment. He ran cooling water into a large tank and engine exhaust through it. Water thus heated passed through the building radiator system.

Waste heat may be used in the following ways:

For Production of Hot Water:

1. Using pure engine jacket water, at temperatures of 110-160 deg. F. No special equipment required.
2. Adding exhaust heat to used jacket water to raise temperature where hotter water is required, as for boiler feed either direct or through a feed-waste-heater on fuel-fired boilers.
3. Heating cold water with exhaust gases.
4. Reheating circulating water (to 130-170 deg.) of a central heating installation.

For Air Heating:

1. Heater in exhaust line.
2. Similar plant, but also using heat of circulating water for preheating.

For Producing Steam:

1. At low pressures up to 7 lb. per sq. in., usually for processes.
2. Medium-pressure steam up to 90 to 100 lb. per sq. in. Such an installation is rarely suitable or economical with diesel-engine installations below 500 hp. In such cases, steam may be used for power generation.

For Producing Distilled Water:

1. Simple distillation.

For Preheating Fuel:

1. Fuel lines, jacketed with hot water or exhaust-gas to preheat heavy fuel oils.
2. Heating fuel tanks or tank cars to better flow or aid unloading.

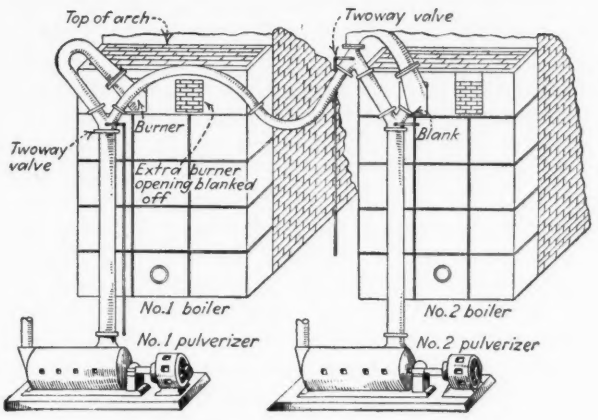
For Producing Power:

1. Exhaust gases drive turbine which in turn drives rotary blower for scavenging cylinder (2-cycle engines).
2. Exhaust gases drive turbine which in turn drives rotary blower for supercharging (4-cycle engines).

For Treating Lubricating Oil:

1. To provide heat in chemical treatment of lubricating oil.

PRACTICAL AIDS TO OPERATION



Pulverized Coal Bypass Improves Boiler Operation

EACH of two boilers in an industrial plant was fired by a unit-mill pulverized-coal system. Two burners were installed for each boiler, the burners being of the Venturi type and located directly below the arch. Average load demand required a coal delivery from the pulverizers of about 3,500 lb. per hr. per boiler. It was found, after this plant had been in operation for some time, that more satisfactory results were obtained by operating with one burner per boiler. This left a spare pipe line from each lateral fitting above the pulverizers.

A further change cut down the expense of running two lightly loaded induction motors driving the pulverizers and also reduced maintenance costs on these two machines.

The spare pulverized-coal line from the lateral over No. 1 pulverizer was turned 90 deg. on its flange. This placed it pointing directly towards the piping of No. 2 unit. A lateral was connected in the pipe line to the burner of No. 2 boiler, and two-way butterfly valves were installed in the lateral connections, as in the figure. The cross-over connection allowed No. 1 pulverizer to be used to take care of light and medium loads on both boilers. Combustion conditions varied but little in the two boilers when operated with one pulverizer at these loads. Winter loads were such that full capacity of the plant was required at times, and the normal summer load could be supplied from one boiler.

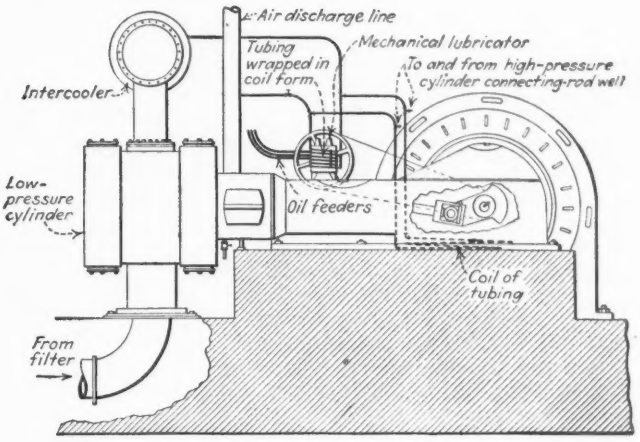
Milford, N. J. HARRY M. SPRING.

Preventing Rusting of Refrigerator Valve Stems

IT IS often found that valve stems on the cold line in refrigerating plants rust and corrode and become difficult to operate. This is due partly to condensation from the atmosphere and to the water or brine that splashes on them. A permanent remedy for this trouble is to have the stems made of stainless steel. If these cannot be obtained, then a sheet metal cover should be fitted to give protection from splashes.

The stems should be kept lubricated. For this purpose we use a mineral oil to which has been added 25 per cent flake graphite. When the stems are worked, if this lubricant is used, the metal will develop a graphite polish, making the valves easier to operate and the stems more resistant to corrosion.

Herts, England. W. E. WARNER.



Air Compressors Operated Outdoors in Cold Weather

WHILE visiting a hydro project under construction, I noticed on the air compressors an attachment for warming the oil that is applicable to similar installations. The compressors had a temporary roof built over them for protection from the weather, and it was desired to insure proper lubrication during very cold weather.

They were two-stage, the cylinders being lubricated by a mechanically operated pressure lubricator. Connecting rod bearings and crossheads were lubricated by splash. Three lines of $\frac{1}{8}$-in. copper tubing were run from the high-pressure air discharge. Each line of tubing was provided with a shut-off valve, one line going to the high- and one to the low-pressure connecting-rod well. At the bottom of the oil well, the tubing was bent into a flat coil and then led to the intercooler where it discharged. These coils were securely fastened to the inside of the oil wells to prevent any chance of their fouling the connecting rods. Line No. 3 went to the mechanical lubricator, made 20 turns around it, and then led to the intercooler.

The loss in efficiency from bypassing the high-pressure cylinder was negligible as compared to the probable maintenance expense resulting from insufficient lubrication. If the air compressor had been steam driven, the same idea might be worked out with steam coils, taking proper steps to guard against condensate leakage into the oil.

Cleveland, O. L. R. BROWN.

Live Trash-Rack Bars Keep Eels Away

A SMALL hydroelectric plant had trouble with eels getting into the racks and turbine casing, eventually clogging up the casing entirely and necessitating shutdowns for unsavory cleanings. Various measures were tried to remedy

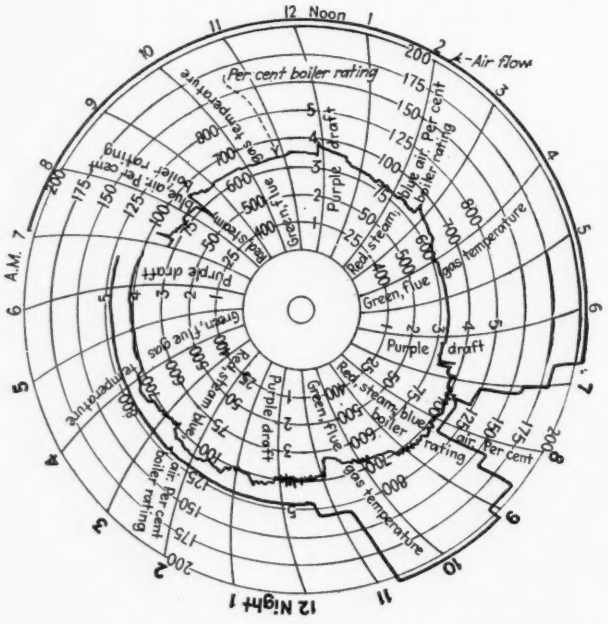
the condition, such as closer spacing of rack bars, without satisfactory results. Then someone suggested making the rack bars alive, believing this would discourage entrance of the eels. The individual bars were then insulated from each other and 55-volt alternating current connected across them. This corrected the trouble, and if any eels did get through the racks, they kept on going.

At another plant, a cofferdam frame was built with 1-in. heavy wire-mesh screen confining 8 in. of 1.5-in. crushed stone between the two sides of the cofferdam. This gave fair results, with only a few eels getting through.

York, Pa. JOHN S. CARPENTER.

Free Air is Expensive

THIS chart is presented to prove that instruments are needed to check the air in a power plant. It was taken from a boiler meter installed on a boiler having about 2,500 sq.ft. of heating surface and fired with gas and oil. This boiler was one of seven on the line at the time the chart was taken. Two of them have 5,000 sq.ft. of heating surface and the rest 2,500 sq.ft. These boilers were all equipped with boiler meters and feed-water regulators and fed from a heater equippd with a V-notch recording meter. Thus, load conditions at the time the chart was made were known. The flue damper was left open on this boiler until, as shown, 6:40 p.m., at which time it was partly closed to cut down the excess air. Since the boiler- and heater-meter charts



showed that the load had remained constant for some time, it was decided to ascertain if possible how much the excess air had affected the boiler output. The results show how much free air can cost.

Without raising the gas or oil pressures or making any adjustments to the burners, the per cent of boiler rating began to rise as the air was cut down. As will be noted on the chart, this was done by steps and for every decrease in airflow, a rise in boiler rating occurred.

At 7:30 p.m. it will be seen that the rating had been raised from 80 per cent to 100 per cent by this method. In order to prove that this gain had been made by decreasing the excess air in the furnace, the damper was again returned to the open position at about 9 p.m. At 10:30 p.m. it will be noted the boiler rating had again dropped back to 80 per cent. At 11 p.m. the excess air was again reduced, and at 12 M. the chart shows that the boiler output again reached 100 per cent of rating. The heater meter showed that the feed-water temperature was 210 deg. F. and the load steady during this test. Each time the excess air on this boiler was reduced the oil pressure was reduced on the other boilers to keep the steam pressure from increasing.

It is not the intention to show the amount of loss by excess air on this particular boiler but to call attention to one of the losses in power-plant operation that can escape notice without proper instruments. This boiler clearly demonstrated that with the same amount of fuel it could have generated 1,700 lb. per hr. more steam than it did. I know of a plant where a 7,500 sq.ft. boiler has been installed, equipped with a superheater, force- and induced-draft fans, air preheater and a setting designed to burn oil at 300 per cent of rating. So far the Powers That Be have turned a deaf ear to the engineer's plea for a steam-flow meter and draft gage with which to operate the boiler, but have reduced expenses by cutting the payroll 15 per cent.

Rockland, Mass. BURTON W. WHEELER.

Retrieving High-Voltage Lost in a Conduit

RECENTLY a 6,600-volt cable supplying power to a circulating water pump in our power house grounded and it became necessary to do a rush replacement job. The cable contained three No. 2 conductors and was lead covered. In the absence of a suitable basket to go over the lead sheath, the new cable was skinned back a short distance so that the steel pulling rope could be attached.

The pull proved to be a hard one, and when the high-voltage cable reached the last 90 deg. bend in the duct, the eye broke loose and left the cable in a position about as in Fig. 1. To have rigged up block and tackle near the live busbars and pulled the cable back would have taken considerable time, so another method was tried. A piece of $\frac{3}{8}$-in. flexible steel rope was secured and looped around a piece of 2-in. conduit. One end of the 2-in. conduit was then placed firmly against the high-voltage cable, Fig. 2, and by means of a rod, Fig. 3, the steel rope was worked down around the cable until it was in the position shown in Fig. 4. The crane was again attached and the lost cable pulled safely to position.

Youngstown, Ohio. DAVID WILLIAMS.

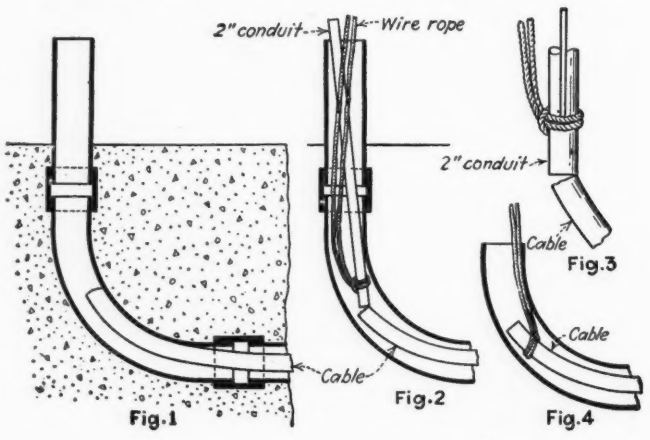
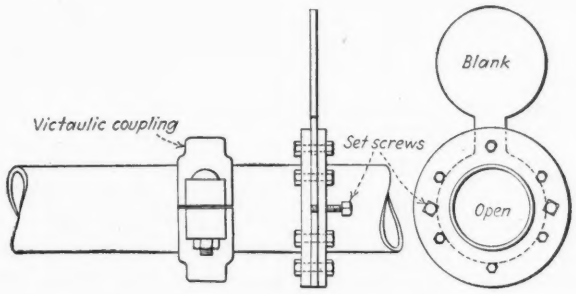


Plate Used as Cutoff In a Larger Pipe Line

On a 14-in. gasoline pipe line, it was necessary to provide an absolutely tight cutoff. A valve could have been used but there would have been danger of a leak which would have mixed with the oil in another part of the manifold system. The problem was solved by using a plate and orifice in the line, as in the figure. This unit was made of $\frac{3}{8}$-in. plate, one end being blanked and the other with an opening equal to the inside diameter of the pipe.

The valve in the line was normally open all the time. Under this condition the open end of the plate was connected between the two flanges as a distance piece. When



the valve was closed, to make certain that no gasoline would leak into the line, the plate was put between the flanges and tightened in place.

To assist in making the changes of the plate in the line, two set screws were tapped into one flange to be used to force the flanges apart sufficiently to remove the plate. As the pipe line was quite long, a victaulic coupling was installed near the flange. In this coupling a small space is left for expansion between the two ends of the pipe. This space was sufficient to allow opening the flange without moving the whole pipe line.

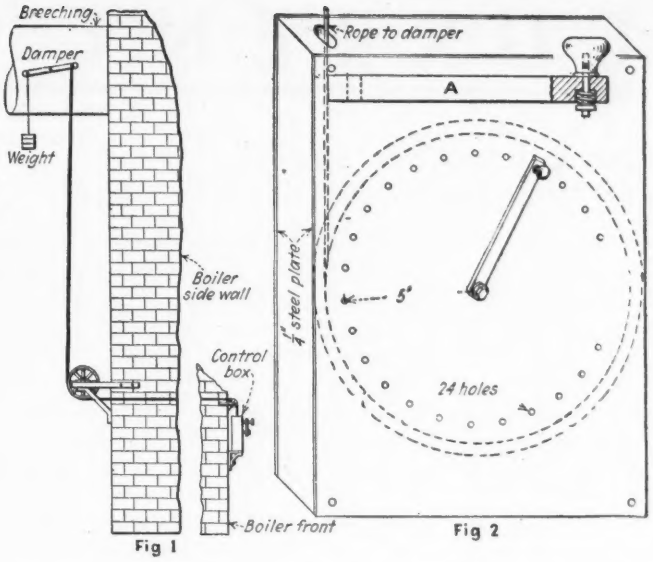
Provisions were made for draining the pipe line back to the pump house before opening the joint, which had to be done at long intervals only. Even though this method was applied to a gasoline and oil line, there is no doubt that there are other places, requiring an absolutely certain cutoff, where it can be used.

Arcadia, Calif. M. C. Cockshott.

Convenient Manual Control for Boiler Damper

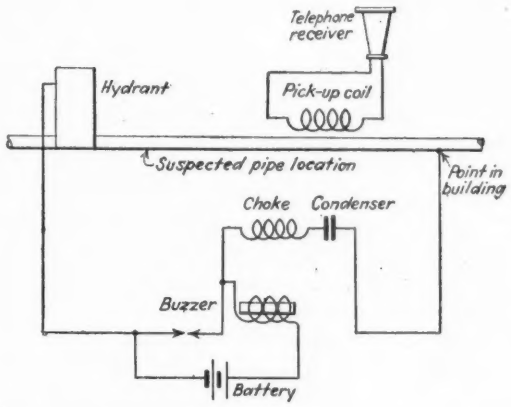
Automatic stokers were installed in a boiler plant, but because the load was fairly steady, air supply to the furnace was controlled manually by adjusting the setting of the damper in the breeching. Originially, a wire hung down from the counterweighted damper arm at the rear of the boilers. The operator, when making changes in the air supply, would have to walk around back of the boilers to adjust the damper. He would then come back to the front of the boiler and look at the pens on the boiler meter to see how nearly correctly he had guessed. Usually it would require two or three trips to adjust the damper.

To permit adjustment of the damper at the boiler meter, a controller was constructed, as shown in the figure. This control was mounted on the boiler front below the boiler meter and provided a convenient method of maintaining good combustion conditions. The essential part of the control is a flanged pulley on which the damper rope is



wound. The pulley is mounted in a metal case and is turned by a lever as in Fig. 2. To make close adjustments of the damper, 24 holes were bored in the front plate of the control case. As shown at *A* a pin is attached to the knob on the control handle, the end of this pin fitting into the holes in the front plate to hold the damper in position.

Chicago, Ill. M. E. Wagner.



Telephone Receiver Locates Underground Pipes

It is sometimes necessary to locate a water pipe buried several feet in the ground. Rather than explore with pick and shovel, a simple device of the type shown in the figure can be used to determine the pipe's location within one foot.

A pulsating current generated by a buzzer is passed through the pipe. A pick-up coil, consisting of several hundred turns of No. 28 wire, wound on a 2-ft. square wooden frame, in series with a telephone receiver, is used to locate the high-frequency current. The sound in the phone is most intense when the coil is nearest to the pipe.

The condenser and choke coil are of such values that they are tuned to the buzzer frequency. For a 500 cycle buzzer, values of 0.5 microfarad and 200 millihenries may be used. The lead from the fire hydrant to the buzzer should be at least 20 ft. from the suspected pipe location to avoid interference. This system is superior to the hit-and-miss, pick-and-shovel method.

Westfield, N. J. Gordon R. Hahn.

CURRENT COMMENT

Pottery Uses Waste Heat Of 75-hp. Gas Engine

THE answers in the July *Power* to the question regarding use of the waste heat from a 135-hp. diesel reminds me of another plan which may prove of interest and value. A crock and jug pottery was powered by a 75-hp. gas engine. The cooling water tank or sump was replaced by a system of pipes consisting of open return ells and standard lengths of 1½-in. iron pipe, this radiating system being suspended from the ceiling in the pre-drying room. Thus the jacket water heat was used in warming the room.

The exhaust pipe from the engine was extended from the upper end of an expansion chamber cooled with a little jacket water, both the exhaust pipe radiation and the heated water being used likewise for room heating.

Cleveland Heights, Ohio. JAMES MCINTOSH.

Welding Pipe Joints to Prevent Leaks

BERNARD KRAMER comments in the July number of *Power,* page 378, on my method of welding a threaded flange pipe joint tight with equipment usually carried in the average plant. I have introduced this method in the plant where I am employed and it has proved highly satisfactory. It takes considerably less gas to make the weld, the weld is under compression when in service and no welding rod is required.

Mr. Kramer states that he prefers the "regularly accepted" way of welding at the back of the flange as it permits repairing without dismantling pipe should the weld prove defective. My main objection to welding at the back of the flange is that extra material is required, both rods and gas, there is a possibility of distorting the flange face and the weld is under tension. The latter condition is one to be avoided wherever possible in pressure vessels of all types.

The use of a ring in joints of this type is not original, as it us used in a well-known type of flanged or screwed union and does not require any comment except that it has proved very satisfactory when used in work best adapted to it.

Michel, B. C. D. J. H. TAYLOR.

Absorption Plant Run With Diesel Waste Heat

IN LOOKING over the articles in July *Power* on the feasibility of utilizing the heat in the exhaust gases from diesel engines, there is one possibility that I have never seen discussed nor tried, so far as I know. I refer to the possibility of running an absorption refrigerating machine with such exhaust gases. Absorption machines have gradually fallen into the discard, principally because of the difficulty of getting competent men who understand the Piquet cycle and the application thereof in practice on a large scale, also because of the large power and water consumption. At present most units are either old ones or are used in plants where a very low temperature is needed, such as dewaxing plants.

Of course it is not contemplated that a refrigerating plant install a diesel to provide refrigeration by such means, but assuming that a manufacturing plant has diesels and wants 25 to 50 tons of refrigeration, the problem becomes simple. All that is necessary is to provide ample ports to the still and see that the exchanger is of ample capacity. This last applies to all absorption plants, the exchanger usually being about half the size that it should be, so that the incoming aqua is only heated about 30 deg. when it should have twice as much heat imparted to it, saving both fuel and cooling water.

The great advantage of absorption plants, other than that of furnishing extremely low temperatures, is that the ammonia does not come in contact with oil at any time, for no system of traps can eliminate oil completely from ammonia, either in a gaseous or a liquid form. Another advantage is that the system can be recharged with either aqua ammonia or anhydrous, as the need arises.

That an absorption plant can compete successfully with a compression plant was shown by the late John E. Starr at Atlantic City some years ago. With machines of his own design, a trial run was made which showed an efficiency of ten tons of ice to a ton of coal. The coal was probably hand-picked Buck Mountain anthracite (Dr. Grimshaw's standard for tests), but the test was a fair one, in summer weather.

St. Louis, Mo. L. R. BAKER.

Is Submerged Combustion Practical?

IT IS conceded that underwater combustion is suitable for a few applications, one of which is evaporation of liquids. But the fact that evaporation is highly efficient and the elimination of the furnace, boiler tubes, etc. is liable to lead many to look upon it as the "forgotten man" and "why didn't they think of it before." We must guard ourselves against a too hasty conclusion as to the more general application of submerged combustion.

It must be stated as a general rule that this method of combustion can never be a paying proposition under any conditions where the steam generated is under pressure, except very low pressures. Under such conditions, the cost of the compression of the air will more than off-set the elimination of the furnace, boiler tubes, etc., and the gain in evaporation efficiency will be outweighed by the loss of work in compressing the air minus the work done by the compressed air. If power for the compression is by-product, the loss in the air cycle will be negligible, but in any case the fuel saving is off-set by greater capital investment.

Let us consider a hypothetical boiler of 1,000 sq.ft., 100 lb. pressure, oil as fuel. The air required is 600 sq.ft. free air per min., and this calls for a compressor with 150-hp. drive. I have estimated the cost of the compressor and its drive, together with the drum and firing equipment, at $8,000 and the cost of the boiler complete at $4,000. The fuel consumption is estimated at $4,000 per year. The saving in fuel is governed by the reduction

in the flue gas temperature, and these have been assumed as 525 deg. for the standard boiler and 225 deg. for submerged combustion. The saving will be about 10 per cent or $400 in favor of the latter method. This is more than off-set by the additional fixed charges, which are (8000-4000) × 13 per cent = $520. So there is a net gain in favor of the standard boiler of $120 per year.

But for conditions of low-pressure steam, such as in heating, the advantage seems to be on the side of submerged combustion. The only extra equipment required will be the fan, and the reduction in fuel should more than off-set this cost. The expected reduction in fuel will be about 10 per cent, but only in localities where oil or natural gas can be purchased at a price equal to that of coal.

In changing from steam to steam-gas mixture, the conventional type of radiator can be used with slight modifications. The steam and gas will be about equally divided by weight, that is for each pound of steam there will be one pound of air; the ratio of the volumes will be 1.0 to 0.6, respectively. If we assume a total pressure at the radiator of 1 lb. the partial pressure of the steam will be 0.6 lb. which corresponds to a temperature of slightly over 200 deg. So that by maintaining the cold end of the radiator at less than 200 deg., the steam will be condensed and the gases discharged. But they must be conveyed out of the room, and the radiators will have to be provided with pipes for this purpose.

Chicago, Ill. N. T. Pef

Work Bench of Welded Pipe

In criticizing the description of R. L. Wagner's welded workbench, as given in his letter to the editor in the August issue of *Power,* it is unfortunate that Mr. Kramer was led to assume that the construction described should require a great deal of skilled labor. It is safe to say that it did not require half the skill to plan and build as would be required if built with pipe and threaded fittings, or with structural angles and bolted attachments. It is, of course, obvious that such a workbench could be built with *almost any kind* of metal parts that might be available, using riveted, bolted or welded attachments, but it should be made clear that what Mr. Wagner intended to convey was an idea of the extreme facility with which pipe, either old or new, can be cut to size and fit, and then welded into place by the oxy-acetylene torch.

From personal observation of such construction, I am willing to hazard a guess that the welded pipe bench construction would go together in from one-quarter to one-eighth the time required to build the same bench with Mr. Kramer's flat iron or angles, including his angle knee braces. No matter whether Mr. Kramer likes the appearance of the welded pipe bench or not, this construction is extremely strong and is much more rigid than an angle frame braced with flat bars and bolted together. He is undoubtedly correct in suggesting that a steel plate top would be better for a workbench to handle ordinary machine construction or repair work. The bench described by Mr. Wagner is, however, used for welding repair work in which the work is occasionally preheated and the table top is often subjected to the heat of the welding flame. For such service Mr. Kramer will, of course, admit that a cast iron top is superior. The only possible improvement on cast iron would be a table top surfaced with refractory brick. The cast iron top shown in Mr. Wagner's illustration is slotted and is found extremely convenient for bolting or clamping parts to be welded.

Long Island City, N. Y. C. W. Obert

Pitting of Water Heaters

On page 380 of July *Power,* W. J. Ryan suggests several methods of protecting the interior of a closed feed-water heater from corrosion. One suggestion is using Portland cement wash. I am in favor of using cement, but not according to his method of mixing. It should be mixed with fine, clean, sharp sand to the consistency of paint, and in the proportion of half sand and half cement, in an ordinary galvanized water pail, and stirred frequently while being used. As soon as it has hardened sufficiently, mix a fresh batch or pailful and apply second and third coats over the first one. Should the heaters have means of ventilation, this coating will be hard enough to put the heater into service in 8 or 10 hr. It may be that from time to time some small pieces will scale off, but this can be easily repaired.

I have protected the interior of several steel tanks used for feed-water storage, and of considerable size, that were found badly corroded. After cleaning and scaling the interiors and applying several coats of cement wash mixed as above, no further corrosion was noted.

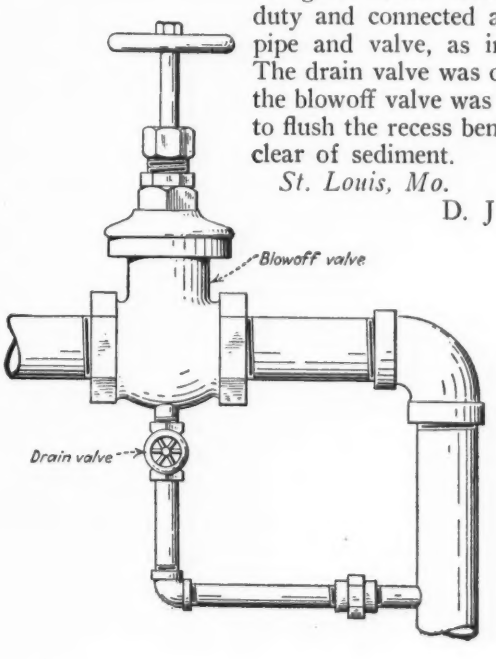
All the tanks aboard steamships for carrying domestic fresh water are protected from internal corrosion by cement. This also applies to feed-water storage tanks.

Troy, N. Y. J. F. Nagle

Gate Valves as Makeshift Blowoff Valves

In some small boiler plants, ordinary gate or globe valves are used as blowoff valves, even though they are poorly adapted to such service. Mud and sediment in the water blown out may lodge under the gate or disk and prevent tight closure.

To avoid this difficulty, the operating engineer in one plant drilled and tapped a hole in the bottom of each of the gate valves used for blowoff duty and connected a small drain pipe and valve, as in the figure. The drain valve was opened, when the blowoff valve was being closed, to flush the recess beneath the gate clear of sediment.



St. Louis, Mo. D. J. Allison

WHAT CAN POWER PLANTS DO ABOUT SMOKE ABATEMENT?

By A. E. GRUNERT*
Efficiency Engineer, Generating Stations
Commonwealth Edison Company

WHEN all the inevitable chemical and physical products of the combustion of Illinois coal are considered, the problem of preventing atmospheric pollution becomes one which requires not only keen technical resource but considerable research. The popular idea of this condition seems to be that any or all objectionable stack discharges can be prevented by simple devices of one kind or another. Perhaps any of the various flue-gas cleaning devices now available will give some kind of a result, some better than others, but I believe there is no practical device or process in existence which gives results which are 100 per cent satisfactory. If the tenor of the many municipal ordinances throughout the country reflects public opinion, it means that nothing but absolutely clean flue gas containing no solid matter or obnoxious gases will eventually be regarded as the solution. Before such a result can be obtained, I think much development and research, with considerable time and expense, will be necessary—and this is stating it conservatively.

About all I am able to discuss at this time is the difficulty of developing better means for preventing objectionable stack discharges and what measures could be considered which may at least reduce the condition.

Illinois coal has been the fuel most commonly used, particularly in industrial plants in this section. It will probably continue to be for economic reasons. This coal is highly volatile and has high ash and high sulphur content, all of which contribute to stack discharge as smoke, dust and noxious gas.

Let us consider some of the conditions with which we have to deal while burning Illinois coal, particularly, the coal from the central fields. I think it can be safely said that combustion conditions in all modern power plants in the Chicago area using this kind of coal are of a high order of efficiency in the generally accepted sense that nearly all the potential heat energy in such coal is actually developed in the furnace. Even if this conversion of heat in the furnace were perfect, we would still have two conditions, in particular, which are inevitable: (1) The combustion gases will contain SO_2. (2) They will carry dust particles of various sizes. With pulverized-coal firing, flue gas carries more dust than with stoker firing, but pulverized-coal firing is with us to stay for economic reasons.

Our investigations have shown that about 80 per cent of the sulphur in the coal is burned to SO_2 with efficient stoker firing and about 90 per cent with efficient pulverized-coal firing. The result of this is about 0.3 per cent by volume of SO_2 in the combustion gases under usual excess air conditions for stoker firing. This is proportionately higher for pulverized-coal firing. The more efficient the combustion, the more SO_2 will be produced.

When means for absorbing SO_2 from flue gas became more urgently demanded, the natural thought was that absorption by water was the means for its successful accomplishment. Sulphur acids were known to have an affinity for water, and this, together with other desirable effects, looked like a good method to try.

The earliest experiments with the so-called washing process that I know of, on a practical basis, were those conducted by the London Power Company several years ago at Battersea Station. The treatment in this case consisted essentially of subjecting the gas to a series of water sprays with both hot and cold water. The sulphur content of the coal was much lower than that of our Mid-Western coals. Results claimed by this treatment (*Power*, August, 1933) in the way of elimination of SO_2 from the gas subsequently encouraged similar development of this or similar processes in this country. Several experimental washing installations were made, mostly on single boiler units. If any practical process or device has developed from this that could stand the test of scientific investigation for real results it has been pretty well concealed.

As these early experiments showed that the solution of this problem required something more than just elementary chemistry, the idea of special research was suggested. Probably the most thorough and intensive research on this matter has been carried on for the past several years by Prof. H. F. Johnstone of the University of Illinois under sponsorship of the Utilities Research Commission. These researches are still in progress. While they have not yet produced a practical solution of the problem, they have added to our store of knowledge and have determined at least what some underlying difficulties are and have given some idea of power requirements for moving the tremendous volumes of gas to be treated.

Dr. Johnstone's early efforts were with the so-called oxygen absorption process which consists essentially of converting the slowly soluble SO_2 to the fast soluble SO_3, the reaction being induced by catalytic agents and the resulting by-product being dilute sulphuric acid. Slow reabsorption of oxygen by the wash-water and poisoning of the catalyst by certain rarer constituents of flue gas were the principal difficulties encountered. The latter could perhaps be successfully combated, but the former meant washing apparatus as big as the boiler house itself, with a large expenditure of power for handling the large amounts of water and gas involved. Even under these conditions, removal of all the sulphur fumes would not be possible. Dr. Johnstone's present researches are with certain direct reaction methods, but any comment on their outcome would be premature at this time.

Unfortunately, the existing ordinances for abatement of noxious gas discharges never specify the manner or means by which the result can be accomplished. The reason is obvious. There are no means. If the provision of a certain municipal ordinance in a mid-west city were enforced down to the last letter of the law, not a furnace would be fired or a wheel turn in the area. What we need is not more and severer ordinances but more co-operative research and construction dvelopment.

The matter of dust elimination has, on the other hand, progressed much farther. There are available today practical means for eliminating upwards of 90 per cent of all solid matter carried in the gas through the boiler unit. They may be grouped into three general classes:

(a) Electrical Precipitation.
(b) Wet Washers.
(c) Dry Centrifugal or Directional Change Types.

While each has its own particular advantages and disadvantages I think it can be agreed that many of them can be depended upon to effect an elimination of 90 per cent or better. Ninety per cent probably sounds like wonderful performance to the layman. Let us consider, for the moment, what this would mean with typical pulverized-coal firing

*From a paper "Principles in Power Plant Operation Essential to Smoke Abatement" before the A.S.M.E. in Chicago recently.

with Central Illinois coal of the following general analysis:

	As Fired	Dry	Pure
Moisture, %	13.62		
Ash, %	12.37	14.32	
B. T. U.	10590	12260	14311

Ultimate-Dry

Ash	14.32
Carbon	65.10
Hydrogen	5.14
Sulphur	5.10
Nitrogen	0.99
Oxygen	9.35

As this coal is efficiently fired in a large modern furnace, about 60 per cent of the ash in the coal will be carried through the boiler unit, and if no eliminating device were used the quantity of ash discharged to the atmosphere would be 160 lb. per ton of coal fired, which would correspond approximately to a dust loading of 3.9 grains per cu.ft. (32 deg. F.) with normal excess air conditions.

Now let us suppose that some dust-eliminating device is installed and elimination is going to be 90 per cent of the dust burden leaving the boiler unit. The amount of ash dust which will still be discharged from the plant is 6 per cent of the original ash in the coal. This would be 16 lb. per ton of coal, which corresponds approximately to a dust loading of 0.39 grains per cu.ft. (32 deg. F.) with normal excess air conditions.

All but 4 per cent of the 94.6 per cent which passes through a 200-mesh screen will pass through a 300-mesh screen and when one considers its impalpable nature the difficulty of its removal seems obvious. The greater part of this burden will probably contribute to the normal dustfall of the community up to about 7 miles with average wind and weather conditions.

It has been estimated that the normal yearly coal consumption in the area of Chicago is about 35,000,000 tons. If this coal were all Illinois coal, burned in pulverized form with the best dust-eliminating device available, and if the discharge all settled within the area, there would be a dust fall of 112 tons per sq.mi. per month. Of course these assumptions are not fully justified, but even with liberal discount, the probabilities can be visualized. The monthly dustfall in Chicago, at present, varies from about 150 tons per sq.mi. in the residential neighborhoods to as much as 400 tons per sq.mi. in certain areas.

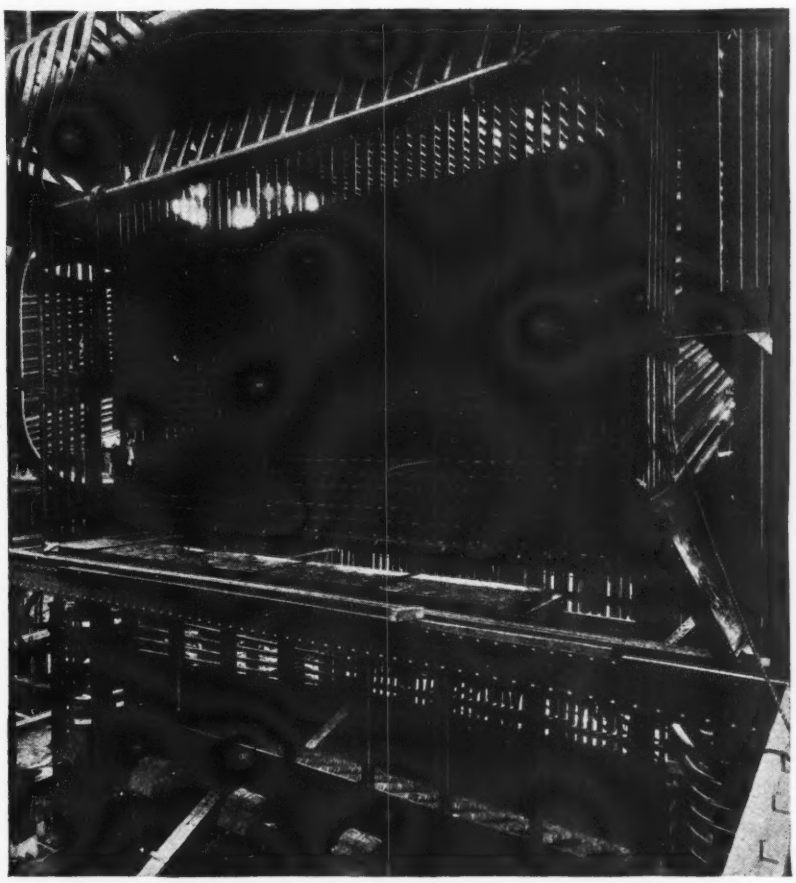
A comparison of this situation with chain-grate stoker firing is naturally suggested. Probably the greater part of Chicago's coal is burned on chain grates or other mechanical types where dust conditions are quite similar. Assuming efficient operation of the chain-grate stokers, probable dust delivery with no eliminators at all will be an amount equivalent to 3 per cent of the original ash in the coal. This would be a delivery of 6.8 lb. per ton of coal or a dust burden of 0.17 grains per cu.ft. (32 deg. F.) with excess air conditions normally carried on these types of stokers. An appreciable part of this dust will pass a 325-mesh screen.

On a basis of the same assumed conditions as previously mentioned, this would mean a dust fall in the cosmopolitan area of 50 tons per sq.mi. per month. It seems logical to conclude that the dust delivery with pulverized-coal firing employing the best eliminating devices available at the present time will be considerably higher than with stoker firing employing no eliminating devices at all. It would not necessarily follow that an elimination of 90 per cent of stoker-fired dust could be effected and I am not therefore proposing that a solution of the dust problem is in the abandonment of pulverized-coal firing equipment. Because of the necessity of the situation, firing of coal in pulverized form will increase and the problem must be considered largely from that standpoint. It is significant that few plant projects are contemplated nowadays without including dust elimination of one kind or another as integral with the plant layout. More and better eliminators are bound to be developed eventually, and the situation is far from hopeless. On the contrary, the situation offers a fertile field for inventive ingenuity and research.

If, in the meantime, much remains to be desired, there may be possibilites of improvement in the situation through the pre-treatment of coal. I do not suggest this as a cure-all or anything approaching it, but if any such practice could be adopted on a basis profitable to both the producer and the consumer, it would seem that it should be considered. I venture to state that the final solution of the dust and gas problem is not any one cure-all proposition, but a combination of prevention, elimination, and furnace design.

Perhaps from a health standpoint we are unduly alarmed about the presence of dust and gas in the air. Two or three years ago, a committee of the best minds was organized, known as the "Pure Air Commitee," sponsored by the A.S.M.E. So far as I know, they have been unable to find out from the medical profession how much dust is injurious or which kind of dust is more injurious than another, whether size plays an important part, etc. They may not know the percentage of SO_3 in the air which is harmful to human tissues or to plant life and they are not sure that it is SO_3 or some other product of sulphuric acid which is really most harmful. It would be a wonderful thing if we could know these things so that our efforts to improve living conditions would be more constructive. Again, there is the ever present difficulty of obtaining proper samples and of analyzing these samples so that we get a true picture. Much will have to be done.

We do know, however, that the elimination of smoke was a big step in making life more enjoyable in large industrial centers and the elimination of dust and noxious gases is the next logical step. We know that the combustion of fuels is not the only source of air pollution from dust or even from gas, but that it is an important one and every industry and every householder should do his share in eliminating air contamination resulting from this source.



Boiler Being Installed at Triangle Heating Plant

One of six 25,000-sq.ft. Walsh-Weidner sectional-header boilers fired by G-E multiple-retort stokers, 15 retorts wide, 45 tuyeres long, being installed at the new central heating plant for a group of new Federal buildings in Washington, D. C. Known as Triangle Heating Plant, it is now nearing completion.

READERS' PROBLEMS

440-Volt Fuses

FUSES FOR A 440-VOLT CIRCUIT—*What voltage fuses should be used on a 440-volt, 3-phase circuit? Would there be any objections to using 250-volt fuses?*—M. C.

Fuses of 250-volt rating should not be used on a 440-volt circuit, as they are not allowed by the National Board of Fire Underwriters Code and under severe short-circuit conditions on 440-volts they are likely to explode. Use 600-volt fuse and cutouts. These fuses have a greater arc-rupturing gap and are of a more substantial design than those for 250 volts.

Generator Alteration

CHANGING GENERATOR FROM 12 TO 110 VOLTS—*A 4-pole, 12-volt direct-current generator having 12 slots in the armature core is to be rewound for 110-volt operation. Will the length of the winding have to be increased 9 times in the armature and field coils, if the machine is to operate at the same speed?*—J. G.

To make the 12-volt windings good for 110-volt operation, it will be necessary to increase the number of turns in them about ten times if the new winding is to be connected the same as the old. It will probably be found best to increase the armature-coil turns about 10 times and the field turns about 9 times. This will favor obtaining the desired voltage from the generator and still have some to spare that can be taken care of with the field rheostat.

If the present armature winding is connected parallel, by connecting the new winding in series, the number of turns in the coils need be increased only five times. The field turns will have to be increased 9 times as before.

Since the armature has only 25 slots, it is quite likely that there are only 25 segments in the commutator. If this is the case, then there are only about five segments between brushes. The voltage between segments is then $110 \div 5 = 22$, which is about double what it should be for satisfactory operation. This difficulty might be corrected by rebuilding the commutator with double the number of segments, the armature would then be wound with 50 coils having one-half the turns in the 25 coils, which means winding two coils in one. The cost of a new commutator and rewinding will probably be such that it will be about as cheap to buy a new machine of the correct voltage.

What Is a Lumen?

LUMENS DEFINED—*There are twenty-four 6.6-amp., 1000-L. lamps in series on our street light circuit. I assume that "1,000 L." means 1,000 lumens. What is a lumen and how many lumens are there per watt?*—V.K.S.

A lumen may be defined as that quantity of light which will, when uniformly distributed over a surface having an area of 1 sq.ft., produce an illumination of one foot-candle on every point of the surface. A foot-candle is the light produced on a surface one foot distant from a one-candlepower light source. A one-candlepower light source will emit 12.57 lumens. Therefore a 75-candlepower light source will emit $75 \times 12.57 = 942.75$ lumens. The lumens per watt taken by the lamp will vary with the type and size of lamp. If the 75-candle-power light source required 40 watts, then the lumens per watt are $942.75 \div 40 = 23.57$ lumens.

QUESTIONS for Our Readers

Diesel on Boiler Fuel?

Question 1

We require a 250-kw. increase in generating facilities. Our present plant uses oil-burning boilers, burning fuel running 18 to 22 deg. Bé. A friend tells me that we can add a diesel engine that will burn this fuel. This would prove attractive for handling our summer load, but will a diesel burn this fuel satisfactorily in comparison with regular diesel fuel costing more? Are there any particular precautions required in the use of this fuel in a diesel? We prefer not to complicate our fuel situation if it can be helped. Which type of engine, air or mechanical injection, would prove better? J.J.P.

Keeping Grease and Oil Apart

Question 2

On our heavy-duty traction motors the load is driven by a gear on which we use a heavy gear compound for lubrication. The end of the motor bearing is ½ in. from the gear and one end is open to the gear case. No oil slingers or baffles of any kind are on the driving shaft. Consequently when bearing clearance increases, oil flows out the bearing end into the gear case and softens the grease. The grease then in turn enters the bearing and causes overheating. I will appreciate suggestions from Power readers. W.A.H.

Suitable answers from readers will be paid for if space is available for their publication.

Opinions on Grounding Practices Differ

ANSWERS to August Question 1

THE QUESTION

Should a 220- and 440-volt, 3-phase, motor-power circuit be ground? We have had considerable discussion on this question in our organization and have not been able to come to a definite decision. Probably some POWER *readers will give me the benefit of their experience and opinion.*—C.R.

Grounding Is a Moot Question

THE grounding of 220- and 440-volt, 3-phase circuits is a moot question. If one point in the circuit is permanently grounded, an accidental ground at another place may result in a short circuit that usually must be cleared to restore service. When the circuit is insulated, an accidental ground does not interrupt service. With one leg of a 3-phase, 220-volt circuit grounded, the voltages of the three legs to ground are 0, 220 and 220 volts, with double these values on a 440-volt circuit If it is possible to ground the middle point of one phase, as in the secondary windings of delta-connected transformers, the voltages to ground of the three legs are 110, 110 and 191 volts in the 220-volt circuit and double these values in the 440-volt circuit. With the neutral grounded on the secondary of transformers, connected star to give 220 volt, the voltage from any leg to ground is 127 volts and double that on the 440-volt circuit.

It is the writer's opinion that it is better not to ground circuits of these voltages, but to ground all motor and control frames thoroughly.

St. Louis, Mo. VICTOR N. FRIEDMAN.

Primary Voltage Determines Grounding Practice

THERE are advantages in both grounded and ungrounded distribution systems, and each has its supporters, some power companies using one type and some the other. However, there are certain features in each type that should influence one in selecting the system to use.

The primary voltage, if high, is a main factor. On undergrounded systems, an insulation fault in the transformers will impress primary potential on the secondary wires and connected equipment. If not cleared immediately, it may seriously injure someone coming in contact with the secondary line. On the grounded system, such an insulation fault usually blows the primary fuses and makes the circuit dead before it can do any harm.

One ground on an ungrounded system will not cause the circuit to open, and operation may be continued until such time as the ground can be removed. However, this particular feature can be a disadvantage, for a maintenance crew may allow

the ground to remain for some time and you have a grounded system.

In general, I favor the ungrounded system, except where the primary voltage is high enough to be particularly dangerous should a transformer fault occur. In such case the system should be grounded on the secondary side.

Chicago, Ill. ROY M. STINSON.

Recommends Grounding the Power System

IF THE 220- or 440-volt, 3-phase motor circuits are fed by high-voltage transformers, the secondary should certainly be grounded in some manner as a protection to life and property in the event of a cross between the high- and low-voltage circuits in the transformer or elsewhere. If the circuits are supplied from low-voltage generators, all ground connections may be omitted, but accidental grounds will develop and may not be detected until they occur on two of the phases.

If it is impossible actually to ground the circuits for any reason, a connection should be made from a transformer or system neutral through a lightning arrestor to ground which will act as an insulator until an excessive voltage is impressed on it and then allow the flow of sufficient current to blow the primary fuses.

The National Electric Code recommends that secondary alternating-current distribution systems be grounded if the voltage to ground exceeds 150 volts, but does not exceed 300 volts and requires grounding where the voltage to ground does not exceed 150.

Altoona, Pa A. R. MARKLAND.

Does Not Recommend Grounding the Neutral

ALTHOUGH it is possible to ground both star- and delta-connected transformer banks when operated 3-phase, this is not often done unless it is desired to procure a single-phase system from one phase wire to the neutral, in which case the neutral is generally grounded. On a grounded 3-phase system, there is greater danger of severe shocks than when the system is ungrounded. For this reason care should be taken to avoid grounding such a system unless necessary. Of course, high-voltage systems are often grounded to provide relay protection. As C.R. states, the circuit is for power but I would not recommend grounding on this type of circuit.

Often telephone interference will result from a grounded neutral, especially if shell-type transformers are used, either of the 3-phase type or three single-phase transformers.

Birmingham, Ala. GRADY H. EMERSON.

Question Considered from Three Standpoints

THE question may be viewed from three angles:

1. Protection of human life, that is, greater safety.
2. Protection of equipment.
3. Improved operation.

Neither of the voltages in the problem can generally be considered as absolutely dangerous to human life, yet conditions may arise where a shock from either might lead to serious accident such as falling from a ladder. On this assumption, in a number of instances it was decided not to ground the circuit.

The arguments usually given for maintaining uniform voltage stress on the insulation due to grounding is essentially theoretical at the low voltages in this problem and need not be considered in detail.

It has frequently been stated that operation of a grounded system involves more frequent interruptions since a fault to ground from one conductor, will cause a short circuit. Experience, however, has not proved this contention. As an actual fact, due to the necessity of keeping the system insulation in good condition to avoid breakdowns to ground, operation actually improves when systems are operated with either a grounded neutral or a mid-point ground in one transformer.

Experience leads me to advocate operating with a grounded system either through a grounding bank or a star-connected bank of transformers.

E. O. VON DANNENBERG.

Brooklyn, N. Y.

Grounding Neutral Reduces Voltage on Insulation

BY SOLIDLY grounding the neutral of a high-voltage, 3-phase system the insulation can be reduced about 40 per cent since the voltage to earth is then fixed at 58 per cent of the line voltage. Should a line conductor become grounded on such a system, the current that flows to the neutral affords a positive means of tripping the faulty circuit.

There would be no saving in insulation if the 220- or 440-volt circuits were operated with a grounded neutral. Because the risk of an outage is much greater on a grounded system as compared with an ungrounded system where continuity of service is of prime importance a low-voltage neutral should not be grounded.

Secondary circuits of 220- and 440-volts are extensively employed in industrial plants, and it is common practice to operate such circuits with one conductor with an accidental ground until repairs can be conveniently made. Needless to say, grounds should be cleared without delay, for not only is there the danger of a second ground, causing a short-circuit, but the arcing that is nearly always present will eventually weaken or sever the conductors. In many industrial plants, lamps are connected to the bus to serve as a ground indicator in order that grounds will be promptly detected.

Oakland, Calif. RAY BARR GLEN.

Operates with the Power System Insulated

I HAVE operated a 550-volt, 40-cycle power system, installed about 1902, that had one leg permanently grounded. This system was supplied from the secondary of a 13,500- to 500-volt, 3-phase bank of transformers. The primary circuit was supplied by a transmission line about 15 mi. long and was subjected to considerable damage by lightning. Occasionally, surges occurred on the high-voltage line due to arcing grounds caused by tree branches blowing against the line or to cracked insulators. After closely observing the system for a number of years, we finally decided to remove the ground connection and operate with the system insulated. In our opinion, less damage occurred with the system insulated than with it grounded. It is important that the frames of all motors and switches be grounded.

Toronto, Ont. J. C. NUTTER.

Many Causes for Pump Losing Prime

ANSWERS to August Question 2

THE QUESTION

We have a 2,000-g.p.m., single-stage, centrifugal pump operating with a suction lift of about 20 ft. and against a discharge head of about 115 ft. Sometimes this pump will lose its prime when in operation. What might be the cause of this trouble and how may it be remedied?—R.E.S.

Says Suction Lift Is Too Great

FROM R.E.S.'s description it appears that the suction lift or head of 20 ft. on the pump is too great. Although theoretically a pump can lift water 34 ft. on the suction side, practical considerations limit this suction head for a single-stage centrifugal pump handling cold water to approximately 15 ft. Moreover, this suction head includes not only the actual height of the impeller above the suction well, but also the friction loss through pipe, strainer, foot valve, fittings and the velocity head.

As high points or loops in the suction line that permit air pockets will cause a pump to lose its prime as will small air leaks, it would be advisable for R.E.S. to go over the pump's suction line and eliminate any air leaks or air pockets and note the pump's operation after their elimination.

A better procedure would be to reduce the suction head on the pump, which can be accomplished by:

1. Lowering the pump, thereby decreasing the vertical lift.
2. Increasing size of suction pipe to decrease friction head.
3. Eliminating unnecessary fittings, making line as short and straight as possible.
4. If strainer is used, cleaning strainer more frequently.

Astoria, N. Y. W. A. JANOS.

Water May Contain Impurities

WHEN the pump is operating at or near full capacity, no trouble should occur from vapor binding, but there is a possibility of

this if the discharge head is increased until the pump is working at a small percentage of its capacity. It is also possible that the water contains impurities with flash points below that of pure water. Under these conditions, trouble can be expected as the temperature within the pump casing can rise to the flash point before being noticeable on the outside, there not being sufficient flow to carry away the heat generated by friction.

While a centrifugal pump will handle considerable air or gas when operating at full capacity, when the flow is reduced the air or gases accumulate in the suction chamber, the result being loss of prime.

Suggestions for a possible remedy are: Examine packing; repack if needed. Take down gland seal lines to see if the pipe is plugged and if water can enter glands. Drill and tap pump at highest point of discharge chamber and install vent or lead-off line of not less than ¾-in. pipe. The valve in this line is to be cracked at all times. The minimum amount of leak-off necessary can be determined by trial. This arrangement has proven satisfactory under similar circumstances.

South Amboy, N. J. RAYMOND SEPTOR.

Trouble in Suction Line or in the Pump

THERE are several reasons why a pump will lose its prime when operating under the conditions outlined in the question. The trouble will probably be found either in the suction line or in the pump itself.

The suction line should be checked to see if there are any leaky joints where the pump can take air. If the suction line ends a short distance beneath the water surface, the pump may lose its prime due to whirls in the water carrying air into the pipe. If a foot valve is used, this may be out of order. Sometimes the threaded end of the suction pipe extends so far into the foot valve that it cannot properly open.

The water seal may become stopped and allow the packing to run dry and air to leak in around the stuffing box. If the shaft sleeve is badly worn, it will also allow air leakage.

If the temperature of the water is high, at times this may cause the water to flash into steam and the pump lose its prime. A maximum allowable water temperature for the conditions under which the pump is operating is about 90 deg. F.

Norwalk, Conn. FRED V. POWELL.

Gives Four Causes of the Trouble

THERE are several reasons why a centrifugal pump or any other pump will lose its prime; among these are:

1. The atmospheric pressure may not be great enough to force water into the pump.
2. The packing on the shaft or rod may be letting air enter the pump.
3. The suction line may be too small to supply the pump with water under certain atmospheric conditions.
4. There may be air leaks in the suction line.

When the pump is in operation, a vacuum greater than 17.7 in. must be maintained at the eye of the impeller in order to provide the suction lift. If any of the conditions mentioned exist to such extent that the vacuum in the suction line measured at the pump will fall to 17.7 in., the pump will lose its prime.

DALTON F. MCDOUGAL.

Mansfield, Ohio.

Suction Lift Is Near the Maximum

THE pump is operating at almost the limit of suction, and any departure from ideal condition will make it lose its prime. Since the elevation at which the pump is located and the temperature of the water are not given, it is not possible to state definitely that the high suction lift is the cause of the trouble. In the table are given the limits of suction lift possible under various conditions.

Elevation, Feet	Temperature of Water		
	60	100	140
Sea Level	26	19	10
2,000	22	13	4
4,000	18	8	2
10,000	11	3	—5

The procedure that should be adopted to remedy the trouble is:

1. Compare the suction lift and temperature of the water with the table. If during certain periods the temperature is too high for the lift, and if the temperature of the water must remain as it is, then the suction lift must be reduced.
2. If no fault can be found in this source, then make sure that the suction pipe is air tight. All branches and all valves that are in any way connected with the suction pipe must be carefully examined for leaks. Also, no branch line should be opened during operation, as the air trapped in the pipe may be sufficient to break the suction.

Some years ago, I was connected with a plant in which the fuel-oil pumps operated under a suction of about 10 ft. To the suction pipe were attached a number of branches with a valve on each, and every time certain of these valves were either closed or opened, the pump would lose its prime. This was finally remedied by repacking the stems of the valves.

Another suggestion is that if this is a feed-water pump, then if the feed valve to the boiler is shut tight for a short period, the pump may lose its prime.

Chicago, Ill. N. T. PEF.

Give Attention to the Seal Rings

TWENTY feet is a high suction lift for a centrifugal pump. To give satisfactory operation, the pump must be in good mechanical condition. The clearance in the wearing rings must be at a minimum. The sleeves on the shaft must be free of grooves or the slightest end play will cause air leakage. The sleeves must fit the shaft snugly to prevent air leakage between the shaft and sleeve.

The demand on the pump must not be great enough to reduce the discharge pressure below 60 per cent of the designed working pressure. Should this occur, the water will be thrown from the impeller faster than it can flow to it, and will result in loss of prime. This condition may be overcome by closing the discharge valve a few turns, or better still, installing an orifice plate in the discharge pipe. The seal water should be taken from an independent source of supply, not from the pump's casing. Sometimes the seal rings become obstructed with a gumming substance from the packing or solid matter from the water. It is desirable to keep the water flowing through the seal rings to prevent such deposits. This was accomplished on some of our pumps by providing the seal rings with an outlet. The outlet had a vertical run of about 18 in. to maintain sufficient head to keep the passage or channel in the seal ring filled. Since the outlet and inlet are at the top of the ring, it is obvious an obstruction must be placed between them in order to force the water to flow around the shaft.

If the pump is operating in parallel with another of the same size and characteristics, the pump in the best condition will take all the load, if the demand is not sufficient for both. The suction valve must be kept closed on the idle pump, if both are using the same suction header, or air will be drawn in around the shaft of the idle pump.

A foot valve in the suction pipe will aid in keeping a centrifugal pump primed.

Cincinnati, O. FRANK R. WALKER.

Trouble May Be Electrical

IF THE pump is direct-connected to a motor, the causes of the trouble may be power-line surges. A fluctuation of line voltage may cause a decrease in motor speed. The pump may not be able to deliver at the lower speed and will lose its prime. The check valve in the discharge line and the foot valve in the suction line should be put in good condition, as these will help to prevent the pump from losing its prime.

A small line from the top of the pump casing to the discharge line of the pump frequently aids pump operation. This merely prevents the accumulation of air in the casing. This line, when used, sometimes becomes so badly corroded that it is practically blocked and should be inspected at intervals to make sure that it is open.

Lakewood, O. JOHN P. SIMONS.

Open Pump to Check Its Condition

I WOULD suggest that R.E.S. open the pump to see if the impeller and sealing clearances are worn or if there are obstructions in them. I have found as much as a handful of pebbles in the sealing grooves. If there is a check valve in the discharge line and it should stick closed for only a short time, water in the pump may flash into vapor and cause a loss of prime.

Naperville, Ill. E. L. JORDAN.

Corrosion in Suction and Discharge Pipes

AMONG the many things that may cause a pump to lose its prime are obstructions in the suction and discharge lines. I have found these lines on some pumps partly filled with dirt and corrosion, which produced plenty of trouble before the cause was located.

Muncie, Ind. JOHN L. WHITE.

THE ENGINEER'S BOOKSHELF

I-C Engines

INTERNAL COMBUSTION ENGINES, THEORY & DESIGN (1933)—*By Dr. V. L. Maleev, professor of Mechanical Engineering, Oklahoma Agricultural & Mechanical College. Published by the McGraw-Hill Book Company, Inc., 330 West 42d St., New York City. 386 pages, 6x9 in. Clothboard covers. Indexed and illustrated. Price $4.*

A quarter century ago, Professor Maleev taught at the Institute of Technology of Tomsk, Russia. After being engaged in teaching and research work there for a number of years, he came to America and became an industrial engineer, doing designing, testing and experimental work. Finally he became head of the engineering department of Western-Enterprise Engine Co., from which he resigned three years ago to take his present position. Thus his experience has given him an unusually good background for a book of this sort—one in which practical and theoretical elements are combined to form a homogeneous whole.

Most previous texts have been purely practical or purely theoretical; no book has given all the necessary design and performance data relating to oil and gas engines or gave a general understanding of the principles involved in the design and operation of internal-combustion engines. This need this volume is designed to fulfill, and it does a meritorious job. It sticks closely to fundamentals, telling what has been done, how it has been done, and why it should be done in a certain way. Thus it becomes equally useful to college students and to practicing designers and engineers. Derivations of most of the formulas used are given, and some explanation of the thermodynamics is included so far as is needed for proper understanding of the theory of internal combustion engines. Illustrations are large and unusually clear, and the text matter covers even such details as methods of handling fuels of various viscosities, starting and reversing, and other details of design.

Arch Dams

ENGINEERING FOUNDATION ARCH DAM INVESTIGATION, VOL. III—*Published by the Engineering Foundation, 33 West 39th St., New York City, 1933. Cloth; size 6x9 in. 128 illustrations; 14 tables; 194 pages. Price $3.*

This is the final volume of the Foundation's report on an experimental study of arch dams, begun in 1922. It is divided into ten chapters: Statements by the committee and recommendations for designing, constructing and testing arch dams; experimental work at Gibson Dam, Mont.; tests on Bull-Run Dam, Ore.; investigation of Emigrant-Creek Dam, Ore.; tests on Clear-Creek Dam, Wash.; tests on Coolidge Dam, Ariz.; strain measurements of dam No. 6, So. Calif. Edison Co.; tests by celluloid models of 80-ft. and 100-ft. Stevenson-Creek Dam; table of data on arch and multiple-arch dams in the U. S.; and a bibliography on arch and multiple-arch dams. This volume represents the results of a tremendous amount of research and engineering study and is an invaluable contribution to the literature on the design, construction and testing of arch dams.

Federal Purchases

METHODS AND PROCEDURE IN FEDERAL PURCHASING (1933)—*By R. J. Monteith, former member Federal Purchasing Board, and A. S. Burack. Published by Bruce Humphries, Inc., 470 Stuart St., Boston, Mass. 349 pages, 6x9 in. Clothboard covers. Indexed and appendixed. Price $10.*

World's largest buyer—purchasing a billion dollars worth of materials and manufactured goods this year—the United States Government buys about 100,000 different commercial and technical items from candy bars to structural steel. This book introduces the seller to the buyer, giving something not previously available in book form—information, instruction and recommendations on every phase of Federal purchasing—and shows purchasing methods and procedure of all agencies of the Government.

The authors are engaged in a consulting service to sellers to the Government, and both have a rich background of experience which enables them to provide many short cuts for the seller, be he large or small. Appendixes give lists of Government purchasing agencies, including important field purchasing offices, arranged by departments and establishments; and lists of retail stores maintained by the Government, arranged by types of stores and geographical location. Also included are 48 pages of facsimiles of standardized Government purchase forms and a bibliography.

Chapters include such topics as: The U. S. Government as a Market, Classification of Federal Purchases, Government Purchasing Agencies, General Procedure in Procurement, Character of Federal Materials, Government Specifications, Conditions in Competitive Bidding, Opening of Bids, Awards, Contracts, Sureties with Bids and Contracts, Methods of Inspection and Test, Transportation and Deliveries, Payments Claims and Suits, Statutes Applicable, etc.

BRIEF REVIEWS

FUEL OILS — COMMERCIAL STANDARD CS12-33 (SECOND EDITION) *For sale by Superintendents of Documents, Washington, D. C., 5 cents*—Effective May 1, 1933, these specifications cover six grades of fuel for various types of fuel-oil burning equipment.

WATER RESOURCES OF WALLA WALLA RIVER, ORE. New *maps and reports prepared by the Department of the Interior describe four power and two reservoir sites on this river. Combined capacity of the power sites is 20,000 hp., and of reservoirs about 36,000 acre-feet.*—Report includes 61 pages of text and can be seen at Washington and in Federal Buildings at Portland and Tacoma, Wash. Maps accompanying it, including those on dam sites and river profile, are published on four sheets. available from the Geological Survey at Washington, D. C. for $0.40 a set.

SULFUR DIOXIDE IN PITTSBURGH AIR. *By Carlisle Schade, Mellon Institute of Industrial Research. Pittsburgh.*—4-page reprint of an article in the "Journal of Industrial Hygiene."

PERFORMANCE OF PROPELLER FANS. *By A. I. Brown, associate professor of heating and ventilating, Ohio State University, Columbus, O. 34 pages, 6x8 in., illustrated. Published by the University as Bulletin 77 of the Engineering Experiment Station. Price 25 cents, limited number of copies available free*—Commercial ratings of propeller fans, particularly of airplane type when analyzed on a basis of mechanical efficiency, show many published results to be inaccurate and unreliable, due to inaccurate methods of testing. This series of tests was made under A.S.H.V.E. procedure. Data given on 21 tests.

POWER AND GAS PUBLIC UTILITIES. *Report No. 44 is now available in printed form from the Federal Trade Commission, Washington, D. C.*—Contains transcript of public hearings on Central Illinois Public Service Co., National Light, Heat & Power Co., and Twin State Gas & Electric Co., all of the Insull group.

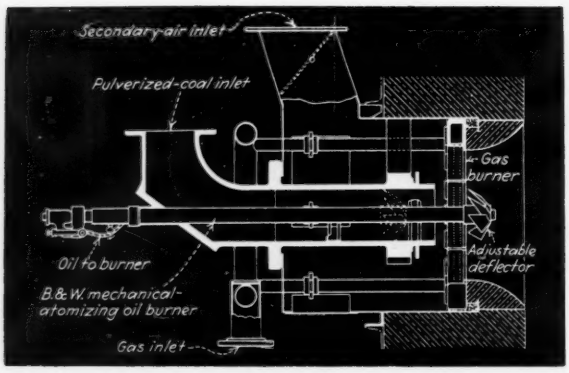
SELECTING, PLANNING AND SUPERVISING "USEFUL WORK." Information in first *annual report of Philadeplhia Technical Service Committee, 1317 Spruce St., Philadelphia, Pa.*—A number of technical societies have been affiliated in the work. Complete data.

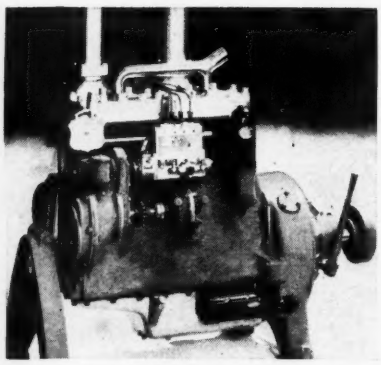
A METHOD FOR RATING THE GRINDABILITY OR PULVERIZABILITY OF COAL. *Developed by the Fuel Research Laboratories, Department of Mines, Ottawa, Canada. By C. E. Baltzer and H. P. Hudson*—A new method correlated with the Cross and Hardgrove Methods.

THE STEAM ENGINE AND THE AIR COMPRESSOR. *By William A. McKay. Available from the author Fairfield Road, Levin, New Zealand. 55 pages, 5½x8½ in. paper covers. 31 figures.*—Describes differential action, generical divisions and action as a roundel as phases belonging to the engine and to the compressor.

GAS MAP OF NORTHERN MONTANA. *United States Geological Survey, Department of the Interior, has issued two maps, one showing recent gas developments in the northcentral United States, the other shows structure, stratigraphy and development to date in the Bowdoin gas field, Mont.*—The first map is on a scale of 40 mi. to the inch, the second on 1 mi. to the inch. Copies available free from the Survey offices in Washington, D. C.

WHAT'S NEW IN PLANT EQUIPMENT

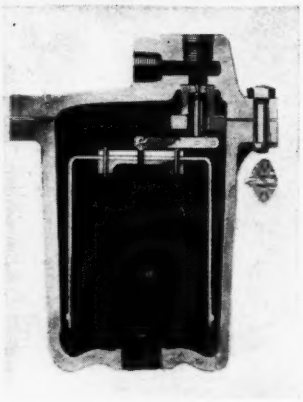




Circular Multi-Fuels Burner

Adapted to combination firing through refractory burner walls and suited to small and moderate-sized industrial boiler units. Burner, of horizontal turbulent type, combines B & W circular burner and B & W mechanical-atomizing oil burner, with necessary additions for burning gas. Liquid gaseous, or solid fuels in pulverized form may be injected into furnace through common circular throat opening, either singly or in combination. Adjustable deflector mounted at furnace end of primary-air and pulverized-coal pipe, insures intimate mixing with secondary air and furnishes high degree of turbulence.

Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.



is forced against gasketed surface by bracket held against cover by two stud bolts. Bracket and seat may be lifted out by removing two stud nuts. Anti-balancing device consists of valve arrangement on bucket which automatically varies air vent during cycle of operation. Unit of semi-steel for low and medium pressures and forged steels for higher and superheat.

Strong, Carlisle & Hammond Co., 1392-1394 West Third St., Cleveland, Ohio.

4-Cyl. Diesel

Monovalve construction permits conventional L-head design with only one valve per cylinder. 4-cyl. "American" diesel operates at 1,200 r.p.m. and develops 75 hp. Fuel consumption 0.44 lb. per b. hp. hr. Engine can be run at speeds from 200 to 2,000 r.p.m. without exceeding fuel consumption of 0.5 lb. per b. hp. hr. or giving smoky exhaust. Engine soon available in 1- to 8-cyl. sizes, using same size parts throughout. Called Model 4-75. Bulletin available.

American Diesel Engine Co., Oakland, Calif.

Smoke-Emission Measurer

According to *The Engineer*, London, this instrument operates on the principle of measuring amount of light obscured by smoke. Four black disks are mounted one behind another at top of handle. Each disk has four projecting vanes which may be arranged in echelon or one behind another, so that when group is spun, light obstruction can be varied from one-fifth to four-fifths. In operation, disks are spun by right thumb through geared star-wheel, while left hand adjusts nut until color of spinning disks matches that of smoke emission. Then instrument is stopped and density read on calibrated scale. Since it can be held in hand and sighted through at smoke column for direct comparison, there is little likelihood of error.

C. F. Casella & Co., Ltd., Regent House, Fitzroy Sq., London, England.

Combination Oil-and-Gas Burners

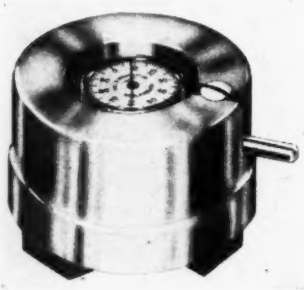
This combination oil-and-gas burner combines features of B & W mechanical-atomizing oil burner with efficient method of burning gas. Gas is broken up into small streams and is discharged at right angles into venturi throat through which air for combustion passes, insuring complete mixing and rapid combustion. Burner is made in heat-liberation capacities up to 70,000,000 B.t.u. per hr. per burner, using natural gas.

The Babcock & Wilcox Company, 85 Liberty St., New York.

Single-Stage Belt-Driven Air Compressor

For heavy-duty service, this single-stage, belt-driven compressor is designated Class ES. Has one horizontal, double-acting cylinder and operates at moderate speeds. Sizes, 10-125 hp., discharge pressures 5-150 lb. Provides economical standby service for large compressors, and can be used anywhere where full-load continuous, economical service is required. Will handle poisonous or inflammable gases also. Crankshaft runs on Timken bearings. Low speeds and effective water jacketing cut discharge air temperature.

Ingersoll-Rand Co., 11 Broadway, New York City.



Vibrometer

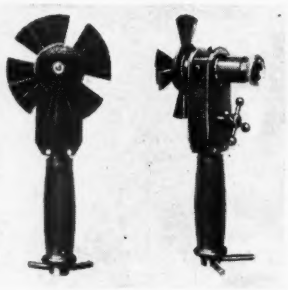
Starrett vibrometer measures amplitude of vibration in machinery and power equipment. Particularly useful for checking balance of units revolving at high speeds. Compact and inexpensive.

The L. S. Starrett Co., Athol, Mass.

Hand-Operated Starter

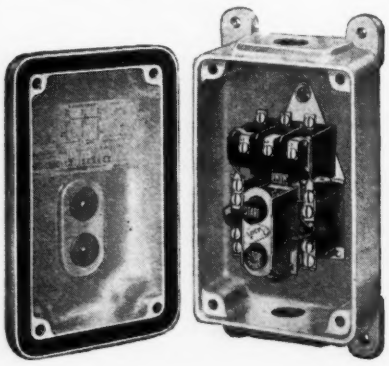
Splash-proof, hand-operated starter for motors up to 3 hp., 110 volts; 5 hp., 220 volts; and 7½ hp., 440-550 volts. Splash proof push buttons.

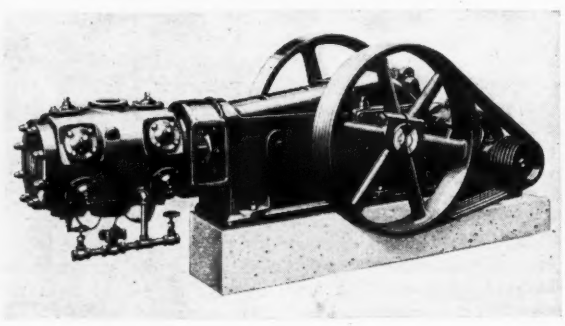
Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.

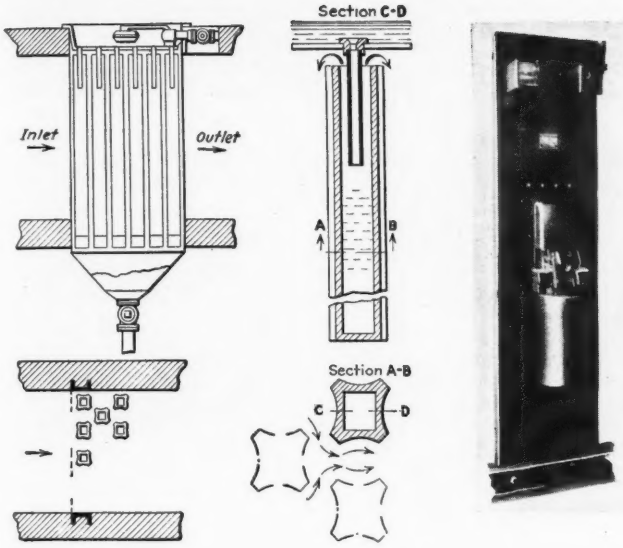


Inverted-Bucket Steam Traps

80 Series inverted-bucket traps have new method of retaining seat in place and anti-balancing device. Instead of screwing seat directly into trap cover or seat holder, seat in this







Dust Arrester

Hanrez-Modave unit, shown diagrammatically, has high efficiency of dust removal, averaging 95% for many installations. Also reduces sulphur fumes; if specially constructed will remove practically all sulphur and all solids in stack gas. No moving parts. Gases to be cleaned are brought in contact with changing film of water flowing over vertical concave-surfaced elements. Water flow controlled from tank above, where constant level is maintained by float valve. Water is led into hollow interior of elements, then overflows and runs down sides. Gases enter at right angles to axes of elements and are swirled past them, losing entrained solids in passage. Agent for manufacture and sale in America:

C. Q. Campbell, 220 Bigham St., Pittsburgh, Pa.

Aluminum Welding Flux

All-purpose Oxweld aluminum flux is intended to replace two fluxes previously marketed by this company, one for welding pure aluminum, other for welding aluminum alloys. Does all other two did and improves quality. Packed in ¼-lb. jars.

Linde Air Products Co., 30 East 42nd St., New York City.

Reclosing Device for Oil Circut Breakers

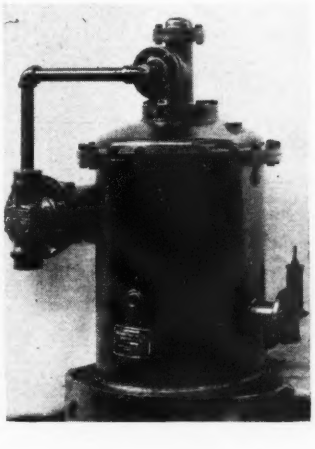
Inexpensive, direct-acting reclosing device, known as Type SM, will reclose an oil circuit breaker one, two or three consecutive times, with equal time intervals between reclosures, when breaker is tripped by overload. If overload disappears after any reclosure, attachment will return to its normal position and breaker will remain closed. If overload still exists after last reclosure, breaker remains locked open and must be closed manually before further automatic operation will take place. Attachment is directly connected to breaker mechanism and is available with both solenoid and motor-operated breakers.

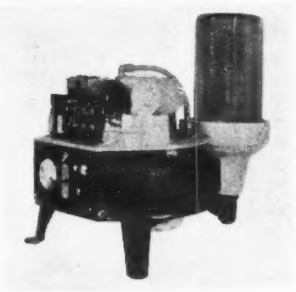
General Electric Co., Schenectady, N. Y.

Deaerating Feed-Water Heater

This deaerating heater, designed primarily for marine service, avoids oxygen corrosion resulting from use of high-pressure steam in steel-tube economizers and steam turbines. Multiple-jet spray used instead of conventional trays. Spray nozzle has two delivery zones separated by floating spool-shaped member proportioned so that sprays are equal and directed at divergent angles. Counterweight on nozzle valve keeps waterspray at constant pressure regardless of load. Water sprayed outwardly into drum-shaped heating chamber subdivided into segmental chambers by radial baffles to avoid difficulties when heater is inclined. Water heated by spraying in steam atmosphere is collected by cone-shaped bottom of heating chamber and delivered to central cone-shaped atomizing valve, from under which is discharged an upwardly directed conical steam jet. This atomizes and deaerates the water, which passes downward to storage space for re-use. Steam and gases pass upward and are used for heating new water entering. Illustration shows heater unit or head for mounting on closed hotwell or surge tank commonly used. Also available as deaerating heater.

Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.

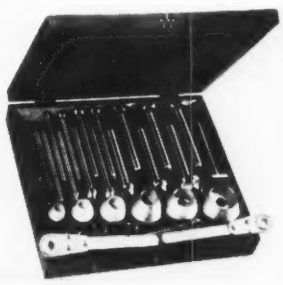




Automatic Water-Hardness Tester

Elgin Hardimeter uses photoelectric cell to test water hardness in zeolite softener and sounds alarm if hardness exceeds specified figure. Instrument, connected to soft water line by small-diameter copper tube, extracts sample periodically (period adjustable 2 min. to 20). Reaction of chemical added with water sample produces turbidity and color change in proportion to amount of hardness, thus affecting beam passing through to cell. Automatic control. Two models, one for use where color and turbidity are fairly constant, other where either varies appreciably.

Elgin Softener Corp., Elgin, Ill.



Valve Reseating Kits

These tools reseat valves from ¼ to 2 in. Tools up to ¾ in. are combination reamers and special thread tap, making unit self-feeding. In larger sizes, reamer and tap are separate tools but otherwise action is same. Smallest kit (No. 1) reseats units ¼ to ½ in., No. 2 kits for ¾ to 1 in., No. 3 for 1¼ and 1½, and No. 4 for ¼ to 2 in. inclusive.

Saver Renewable Seat Tool Co., 549 West Randolph St., Chicago, Ill.

Neon Glow Lamps

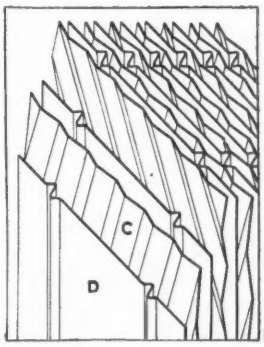
Four sizes, ½, 1, 2 watts for 110-120 volts and 1 watt, 100-550 volts. First three have resistance built into base and fit medium-screw sockets. Smallest size for a.c. only; others either a.c. or d.c. Last type uses resistance in series and fits candelabra screw socket. Used for indicator or marker lights, stroboscopes, or determining d.c. polarity, signal lights, etc.

Westinghouse Lamp Co., Bloomfield, N. J.

New Heating Surface for Air Preheaters

A new type of heating surface is now used in Ljungstrom air preheaters, which permits reduction in preheater volume, weight, and in fan power requirements for a given delivery. In early Ljungstrom air preheaters, heating surface consisted of corrugated metal sheets separated by flat metal sheets to form a multitude of parallel passages of triangular cross-section. With this design, straight-line travel of air and gas through passages permitted smooth flow and sluggish heat transfer.

To overcome this objection, original design was superseded by one in which flat plates were



replaced by crimped plates, having their undulation crosswise of the corrugations in the companion plate, and crosswise to stream of air and gas flow. The turbulence of flow so created increased heat-transfer ratio.

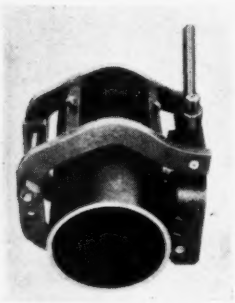
Further experimental work, carried on with a view to obtaining still higher heat transfer efficiency, lower resistance to fluid flow, and greater freedom from soot and fly ash deposit has resulted in the improved design shown (⅓ actual size). In this latest design, crimped sheets *C* have their undulations sloping at 30 deg. to the path of fluid travel, and in opposite directions in alternate sheets. Corrugated sheets have been replaced by flat sheets *D* having longitudinal spacing ribs.

Tests of this new construction are said to have developed the highest rates of heat transfer known to regenerative heat

surface, and have shown a marked reduction in resistance to flow.

Heating surface of this new design is interchangeable with that of older designs, and capacity and recovery of a Ljungstrom heater can be substantially increased by substituting new heating surface.

Air Preheater Corp., 40 East 34th St., New York City.



Pipe-Welding Clamp

Oster "Bull-Dog" pipe-welding clamp is adjustable for all sizes within range, two ranges now being available, 4-6 in., and 8-12 in. Other sizes later. One lever controls action, centering two lengths of pipe and controlling distance between by means of screw spacers. Open construction leaves space for tacking. Welded-steel construction makes weights 18 and 26 lb.

Oster-Williams, 2057 E. 61st Place, Cleveland, Ohio.

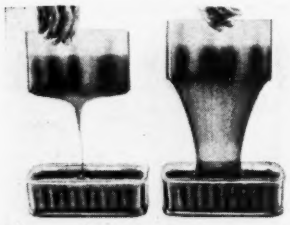
Improved V-belt for Multi-V-Drive

This improved Goodyear Emerald Cord V-belt is now used with Worthington Multi-V-Drive. Has high power capacity, long flexing life and low stretch. Basic feature is greater concentration of load-carrying capacity about neutral axis of belt. Nos. 0, 1 and 2 sizes have one endless cord in one plane, Nos. 3 and 4 sizes have two endless cords in two planes. All cords are embedded in rubber, thus affording full insulation to control internal heat. Tension and compression sections rubber, with layers of fabric through compression section to prevent excessive flexibility. Belt molded to shape and enclosed in fabric envelope to protect working elements and provide good contact surface. Threads of envelope run on "bias" to avoid envelope taking part of load. Envelope "flipped" on belt, not spiraled, and so placed that edges overlap on top or bottom of belt to produce smooth unbroken contact surface on contact faces and avoid fraying.

Worthington Pump & Machinery Corp., Harrison, N. J.

Industrial Lubricants

"Sta-Put" lubricants have high film strength due to special polymerization treatment. Pure mineral oil, polymerized under controlled heat and pressure, according to manufacturer, results in rearrangement of oil molecules without changing chemical content, thus producing closer bond and increased film strength. Tests indicate 40 to 65 per cent increase in film strength and reduced spatter and dripping.



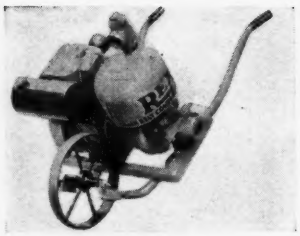
Made in three series, in grades for nearly all types of industrial equipment. 300 series liquid, ranging from light machine oils to heavy; 400 series for gear lubrication; 500 series are grease consistency. Illustration compares film-forming properties of straight mineral oil (left) with same oil after Sta-Put treatment.

E. F. Houghton & Co., 240 W. Somerset St., Philadelphia.

Leaded Lubricant

"Bestolife" has pure metallic lead base instead of lead salts, lead being in finely divided particles in lubricant vehicle. Percentage of lead ranges from to 10 to 65. Withstands temperatures to 430 deg.; loses lubricating stability completely at melting point of lead, 590 deg. Forms thin protective film of lead on all contacting surfaces. Used for pump and valve stem packing lubricant, plug cocks, bearings, gears and belt dressing. Bulletin available.

Armite Laboratories, 1450 East 61st St., Los Angeles, Calif.



3-in. Self-Priming Centrifugal Pump

REX self-priming unit is of recirculating type and is automatic in action after recirculating system is once filled. Unit weighs 385 lb., is 34 in. high and 37 in. wide. It is readily portable and is capable of following capacities: 5-ft. suction lift, 20,400 g.p.h.; 15-ft. suction lift, 16,500 g.p.h.; 25-ft. suction lift, 9,000 g.p.h. Incorporates self-priming device known as "prime control." Impeller is of open trash type with two blades. Can handle high percentages of solids, and will pass a sphere up to 1½ in. in diameter. Powered by 6-hp. air-cooled engine. Electric motor-driven speed primer can be furnished with suitable power unit. Bulletin 230.

Chain Belt Co., Milwaukee.

Photo-Electric Relay

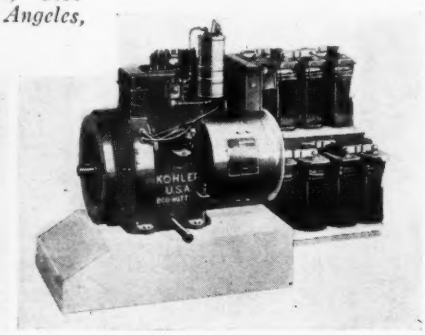
Uses Visitron F2 photo-electric cell which operates without external source of voltage and without amplification. Unit, called FSE, is housed with auxiliary electromagnetic relay in compact cast aluminum case 6¼x5¼x4 in. Cell can be mounted behind glass window in front of case or externally several hundred feet away. Cells, auxiliary relays or the two relays in combination can be supplied assembled or individually.

G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.

Small Electric Plant

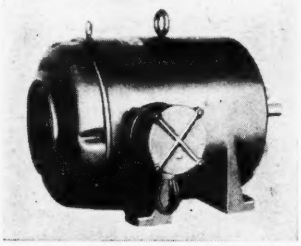
Small, low-cost unit has 2-cyl., valve-in-head, 1¾-hp., air-cooled engine and develops 800 watts at 32 volts d.c. Either automatic or manual control and either battery-charging or non-battery units. Other units 800 watts to 25 kw., 110-220 volts a.c. or d.c. and 32 d.c.

Kohler Co., Kohler, Wis.



Totally-Enclosed Fan Cooled Motor

Same sizes as ordinary open motors of same ratings, these totally-enclosed fan-cooled units provide full protection against explosive dust, corrosive gases or fumes, current-carrying dust,



and steam or moisture. Two shells, inner shell dust-tight and enclosing windings and rotor. Fan between shells provides cooling. All sizes from 1 to 200 hp. as squirrel-cage induction motors for all classifications of torque and inrush requirements and with 1, 2, 3 or 4 speeds. Also as across-the-line start motors up to 200 hp. and can be supplied for power factor correction

Ideal Electric & Mfg. Co., Mansfield, Ohio.

Collector-Ring Grinder

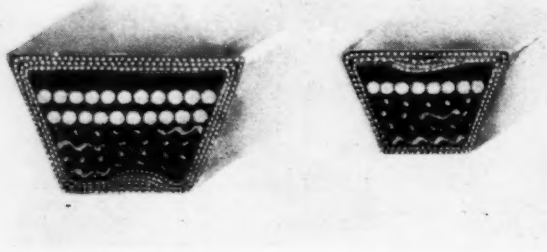
"Luft Model" grinder trues collector rings while they run at normal operating speed. Restores rotaries to about 50 per cent capacity in a few minutes. Replaces lathe recutting. Head of unit is removable and has three different types of supports, short (brush arms spaced 5 to 6½ in.) long (brush-holder studs spaced from 6½ to 8 in.) Both are adapted for 1¼-in. diameter studs, or use sleeves with smaller sizes. Right and left supports available for use where brush holders are held by bolts on yoke. Furnished undrilled. Units available for iron, steel, bronze and brass ring grinding and for following size resurfacer tools: 2x2x8-in., 2x1x8-in., 2x1x8-in.

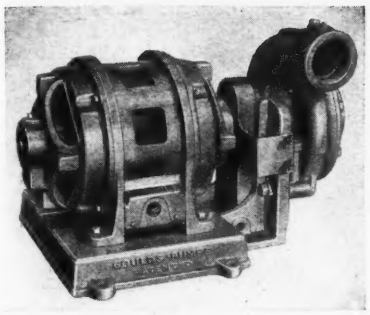
Ideal Commutator Dresser Co., Sycamore, Ill.

Wheel and Gear Puller

Improved "Steelgrip" universal wheel and gear puller consists of heavy bracket with large pulling screw and three chains of any desired length. Will handle work at any distance from shaft end. Chains are double-ended, with standard chain hooks for gripping around spoked wheels or large gears on one end and special hooks for close grips on bushings, small gears, motor pulleys or close quarters. Two capacities, 12,000 and 36,000 lb.

Armstrong-Bray & Co., 308-310 Sheldon St., Chicago, Ill.





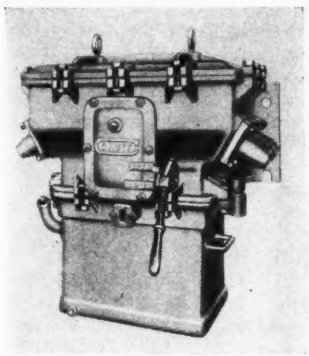
Motor-Centrifugal-Pumping Unit

Compact and low in cost, this unit uses new close-coupled mounting permitting standard motor without bedplates and brackets. Pump bedplate extends under motor to avoid excessive strain. Sizes ¾ to 4-in.; capacities up to 1,000 g.p.m. Heads 10 to 290 ft.; 1,750 or 3,550 r.p.m. Bulletin 204.

Goulds Pumps, Inc., Seneca Falls, N. Y.

Subway Oil Switch

Type EM-50 subway oil switch of water-tight construction for wall mounting in subway or manhole or other locations where there is danger of flooding. Furnished with single-conductor cable sleeves or multi-conductor cable bell. Since subway switches are usually



less adequately protected from line surges than station breakers, insulation characteristics are considerably in excess of A.I.E.E. requirements. Furnished manually operated, non-automatic, 2-, 3- and 4-pole single throw, and 2- and 3-pole double throw, with or without interlocks, for 200 and 400 amp. at 7,500 volts.

Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.

Loose-Pulley Oiler

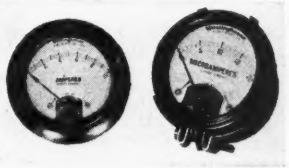
"Vosta" oiler for loose pulleys provides dependable, economical lubrication from visible supply. Consists of glass body and bronze base in which tube is mounted, extending to near top of bottle. As pulley revolves, oil is thrown outward

by centrifugal force. Feeding is governed by thermal principle —periodic expansion and contraction of air within reservoir due to temperature changes. Illustrated and described in Booklet F-524.

Lunkenheimer Co., Cincinnati, Ohio.

Supersensitive Instruments

Scale deflection of 0.20 microamperes and 0-3 millivolts on these units are result of three improvements: reduction in weight of moving parts, 3-1 increase in magnet strength and 6-1 incr se in possible number of turns on moving coil. Sensitivity attained by relatively slight improvements in many fundamental parts. Instruments only 2 or 2⅞ in. in

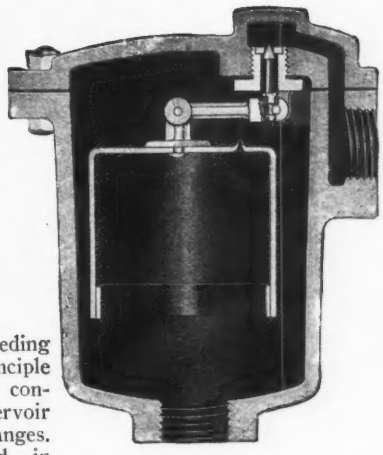


body diameter, giving full scale deflection on one or two microwatts. Lowest standard microammeter has scale 0.20 microamperes and coil resistance of about 2100 ohms. Millivoltmeters are available with scale of 0-3 millivolts and resistance of about 9.1 ohms, Type "NX" on left has moldarta case and is arranged for flush mounting, outside diameter over flange being 3½ in. Type "MX" microammeter on right makes low current ranges of 0-20 microamperes possible.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Inverted-Bucket Type Steam Trap

Marsh No. 500 inverted-bucket steam trap will handle considerable volumes of condensate. Self venting. Motive element is inverted seamless open bucket operating through cast-brass lever arm to open and close swivel valve pin. Body and cover cast iron. Bucket copper, levers and clevises cast bronze, pins, valve and seat stainless steel. All pipe connections to body; thus top can be removed without disturbing pip-

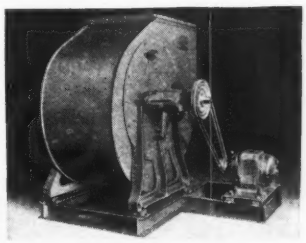


ing. Working pressures up to 125 lb. per sq.in. Three sizes, ½, ¾ and 1 in.

Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.

Silent Fan Base

Flexible rubber insulators, designed so that no contact occurs between bolts or other metal parts of fan and base, quiet this ventilating fan. Rub-



ber insulators are in shear rather than compression, giving greater life and flexibility. Practical means of removing traces of motor hum normally magnified by fan and base.

Buffalo Forge Co., Buffalo, N. Y.

High-Pressure Union

For high-pressure oil, water, gas and air lines, U. S. Union has two serrated ends, on hard, other soft, which form four distinct seats instead of usual one. Can be reused; making up does not spoil seats. Black or cadmium finish. Withstand vibration, temperature variations or pressure variations. Manufactured by Mergenthaler Linotype Co., and distributed through its subsidiary.

United Superior Union Co., 29 Ryerson St., Brooklyn, N. Y.

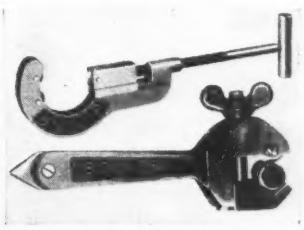
Switchboard Instruments

Type E45 units are suitable for first-grade switchboard work and are 5 in. across front flange. Type S30 are smaller and lower in cost, and are 2⅝ in. across flange. Four standardized types of panels for average requirements included specials on order. Bulletin MS-1.

Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland,

Pipe Cutters

Two new Beaver units include No. 100 tubing cutter (below) ⅛ to ⅞-in., and Square-Built wheel cutter, 2½ to 4-in. No. 100 is particularly used for copper. Renewable-blade reamer on han-



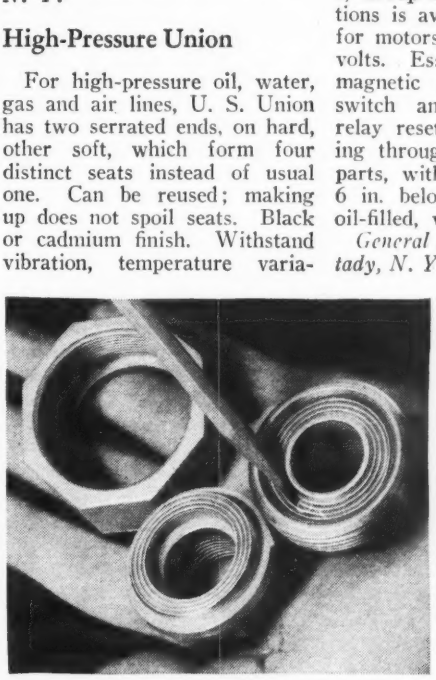
dle. 6 in. long. No. 204 has surface-ground frame to produce working surfaces that are true and parallel.

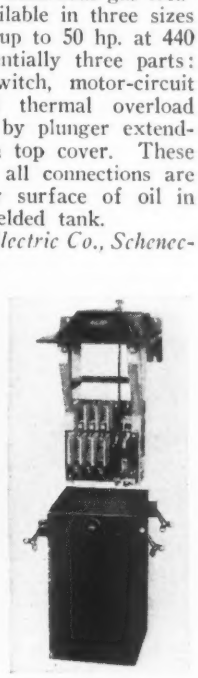
The Borden Co., Warren, Ohio.

Oil-Immersed Explosion-Proof Switch

CR7008 oil-immersed combination switch for use in Class I, Group D hazardous gas locations is available in three sizes for motors up to 50 hp. at 440 volts. Essentially three parts: magnetic switch, motor-circuit switch and thermal overload relay reset by plunger extending through top cover. These parts, with all connections are 6 in. below surface of oil in oil-filled, welded tank.

General Electric Co., Schenectady, N. Y.





POWER LINES

Wanamaker New York Store to Generate Own Power

Following a year's experience in purchasing its power requirements, and as the result of a recent heat, light and power survey made by the engineering office of Louis T. Klauder, Philadelphia, the management of the John Wanamaker New York Store has concluded to resume generation of power in its own plant.

The Wanamaker Store power possibilities are, as in many similar installations, predicated on its large heating (building and hot water) requirements, from which power in large part becomes a by-product. Heat balance will eventually be accomplished by coordinated operation of existing steam and electric facilities or provision of such additional auxiliary equipment as operating conditions may prove necessary.

Central-Station Output Holds Well Above 1932

Central-station output for the week ended Sept. 16, given by Edison Electric Institute as 1,663,212,000 kw.-hr., exceeded by a small margin the previous high for the year, attained in the last week in July. As it has recently, production continues almost identical in amount with that of corresponding weeks of 1931. The gain in the same week over 1932 figures increased to 12.7 per cent. Mountain States and Central Area continue to report largest gains. Middle Atlantic, West Central and Southern States also show higher percentages.

New Code Issued for Safe Ending Boiler Tubes

The National Board of Boiler & Pressure Vessel Inspectors has recently issued new rules, "Requirements for Repairs by Fusion Welding of Boilers and other Pressure Vessels." One section of this code states that tubes of fire-tube boilers, reended by the oxy-acetylene process, will be acceptable when the tubes have no more than two circumferential welds.

Power Engineers Elect John A. Prudell President

Adoption of a national code for power engineers, providing a 30-hr. week and a minimum $1 wage, was voted at the final session of the meeting of the National Association of Power Engineers in Buffalo, N. Y., Sept. 1. John A. Prudell, Milwaukee, vice-president for the past year, was elected president. George M. Diebold, Buffalo, was elected national vice-president; Fred W. Raven, Chicago, secretary; Edward J. Burke, Philadelphia, treasurer; Charles A. Belmore, Boston, conductor; Ernest E. Bailey, Des Moines, doorkeeper; and Thomas A. Gambute, Detroit, trustee for five years.

Minneapolis, Minn., was selected as the 1934 convention city. Approximately 200 delegates and officers, and 2,000 in all, attended the convention and accompanying power show. Edward P. Gilroy of Buffalo was in charge of the exposition as exhibit chairman. He is chief engineer of the Hotel Statler, Buffalo.

Harshaw Chemical Installs New Boilers in Elyria Plant

Originally planned for construction in late 1931, but delayed because of business conditions, work is now being rushed on a new boiler installation at the Elyria, Ohio, plant of The Harshaw Chemical Co. It is expected to raise steam about Nov. 1.

Existing steam generating equipment is being completely replaced with two No. 341 B & W-Stirling boilers with welded drums (a type of construction approved for this only a year ago) in a new 40 x 40-ft. brick boiler house. The new boilers are to be set as a battery with a common center wall. Mud drums are being set high enough to permit placing Buffalo Forge forced-draft turbine-driven fans beneath them. The radial brick chimney, 175 ft. high, and 6 ft. in diameter at the top, will be big enough to carry both boilers at 200 per cent rating. Normal boiler operation will carry one boiler up to 175 to 185 per cent of rating before putting the second boiler into service.

In conjunction with the construction of the new boiler house, there is being installed a completely new main steam line (10-in. headers, 8-in. branch feed lines, 6-in. minimum size lines used) which, running outside all buildings, is being arranged so that additional branches can be readily tapped into the main line without service interruption.

The Elyria boiler installation closely duplicates that already in place at the Company's Cleveland plant. From experience with the latter it is expected that a minimum yearly efficiency will be between 70 and 75 per cent; that steam will be generated at a maximum cost of 40 cents per thousand with 9 pounds of water evaporated per pound of coal, assuming 12,000 B.t.u. coal as fired.

Boilers are fired by single retort Westinghouse underfeed stokers. Bailey boiler meters and automatic overfire draft control are provided to aid operation. Make up water is expected to be about 40 per cent. Water will be obtained from Lake Erie, softened with sulphate treatment and heated in a Knowlton feed water heater.

Superheater Company Takes Over Air Preheater Corp.

As of Sept. 12, The Superheater Company, New York acquired an interest in and assumed the management of The Air Preheater Corp., Wellsville, N. Y., manufacturer of Ljungstrom air preheaters. Air Preheater retains its corporate identity under new management, and will continue manufacture of its products at its Wellsville plant. H. S. Colby will remain in the organization as vice-president. Its executive offices will be consolidated with those of Superheater at 60 East 42nd St., New York. Air Preheater sales activities will be coordinated with the Industrial Department of Superheater, with headquarters at that address, and of which William T. Conlon has lately been made manager.

Conventions & Meetings

The National Board of Boiler & Pressure Vessel Inspectors will hold its ninth annual convention at Hotel McAlpin, New York City, Oct. 17, 18 and 19. The National Bureau of Casualty Underwriters is cooperating.

American Gas Association held its 15th annual convention in conjunction with the International Gas Conference in Chicago Sept. 25-29. Papers included "Natural Gas Developments," "Research Achievements" and a number of others.

The Third International Heating & Ventilating Exposition is to be held in Grand Central Palace, New York City, Feb. 5-9, 1934, in conjunction with the annual convention of the American Society of Heating & Ventilating Engineers. Exhibits will include such divisions as combustion, steam heating, warm air heating.

As this number of *Power* goes to press, the 13th fall meeting of the American Welding Society is in progress at the Book Cadillac Hotel, Detroit, and National Metal Week and the National Metal Congress are also in progress there. Most of the welding papers this year refer rather specifically to welding in other fields than that of power, although one or two affect the field generally. The AWS program includes 29 papers. Five other technical societies are also holding sessions here during the same week. Among them is the American Society for Steel Treating, which will probably adopt the new name recommended for it by its board of directors, "American Metals Society."

International Acetylene Ass'n held its convention in Chicago Sept. 26-29. Included in the program were papers on welding and cutting in refrigeration and air conditioning, hard-facing, possibilities of the oxy-acetylene process in the brewing industry, rehabilitation of breweries, pipe welds and weld tests, welding alloy steels in the process industry, and a number of others less closely associated with the power field.

"Uses for Coal" will be the subject of a meeting of the Coal Division, American Institute of Mining & Metallurgical Engineers in Columbus, Ohio, Oct. 27 and 28. Included in the papers are: A paper by R. A. Sherman, assistant director, Battelle Memorial Institute, on "Relative Efficiencies of Various Fuels in Relation to the Costs and Their Advantages;" "Uses for Coal in the Ceramic Industry," by H. E. Nold, Ohio State University; "Selection of Coal for Small Stokers," by C. A. Reed, chief combustion engineer, Pittsburgh Coal Co.; report from the Committee on Evaluation of Coal for Blast Furnace Coke, by Ralph H. Sweetser, chairman; "Utilization of Pennsylvania Anthracite," by Allen J. Johnson, director, Anthracite Institute Lab.

OBITUARIES

CHARLES E. F. CLARKE, 70, president of the Pennsylvania Water & Power Co., Baltimore, Md., died Aug. 25.

LLOYD F. LAYNE, 41, president of Layne & Bowler, Inc., and its subsidiaries, and nationally known well builder, died at a hospital in Memphis, Tenn., Sept. 7, after a brief illness with pneumonia.

NORMAN C. ROSS, 60, Lakewood, Ohio, turbine specialist for General Electric Co. in the Cleveland district, died recently after an operation. He had been with GE since 1890.

GEORGE CLINTON WARD, 70, president of Southern California Edison Co., Ltd., Los Angeles, Calif., and a distinguished figure in engineering and electric utility circles, died there Sept. 11. He was

builder of the company's hydro system in the High Sierra of central California. He became vice-president in charge of construction of the company in 1917, when it was consolidated, and had gone steadily upward since that time.

PERSONALS

GEORGE B. KARELITZ has resigned as manager of the Marine Engineering Division, Westinghouse Electric & Mfg. Co., South Philadelphia Works, to become professor of mechanical engineering in Columbia University. Mr. Karelitz also intends to engage in consulting practice.

GILBERT L. YETTER, formerly materials engineer in the Bureau of Construction & Repair, Navy Department, has been appointed welding engineer for the Bureau of Reclamation, Department of the Interior, assigned to the Boulder Canyon project. He is supervising inspection of the welded steel penstocks.

GORDON FOX, who has been associated with the Leningrad staff of Freyn Engineering Co., has returned to this country to resume his activities here.

CHAS. F. NORTON, former vice-president and general manager of Howell Electric Motors Co., has joined The Louis Allis Co., Milwaukee, in an executive sales capacity.

A. L. KIMBALL has been transferred from the staff of the research laboratory of General Electric, Schenectady, to the engineering general department, will be associated with A. R. Stevenson, Jr., and will assist design engineering departments on problems involving ventilation, vibration and noise.

CHARLES V. FOULDS, formerly chief engineer, Pelton Water Wheel Co., has opened a consulting office in hydraulic and mechanical engineering in the Call Bldg., San Francisco.

F. F. BRAND has been appointed assistant to the manager of the Pittsfield Works in charge of engineering, I. H. Sclater, engineer of the power transformer engineering department, and LeRoy S. Schell, assistant engineer in charge of the design of all power transformers from 501 to 7,000 kva., it has been announced by L. E. Underwood, manager of the Pittsfield, Mass., works of General Electric Co.

BUSINESS NOTES

NORTHERN EQUIPMENT CO., Erie, Pa., has appointed C. H. Wilson, 1403 Park Blvd., Troy, N. Y., as Albany district representative.

THE ROLLER-SMITH CO., 233 Broadway, New York, N. Y., has appointed H. R. Houghton, 211 North Calvert St., Baltimore, Md., as district sales agents for the State of Maryland.

MINNEAPOLIS-HONEYWELL REGULATOR CO., LTD., has opened a third Canadian branch at Calgary, Alta., at 710 Second St., West, with V. J. Jenkinson in charge.

THE SARCO CO., New York, N. Y., has appointed the following new representatives: E. R. Clement, 1414 W. Broad St., Stratford, Conn.; Evans Construction Co., Scottsdale, Ariz.; P. J. O'Meara, 50 Hawthorne St., San Francisco, Calif.; George R. MacGregor, 706 Cottage Grove Ave., South Bend, Ind.; J. E. Pearson, 3805 Montana St., El Paso, Tex., and C. H. Penningroth, 1617 Curdes Ave., Fort Wayne, Ind., for their line of traps and temperature regulators.

ERIE CITY IRON WORKS has appointed Harry A. Pillen as district sales agent with offices at 622 Broadway, Cincinnati, Ohio.

SULLIVAN MACHINERY CO. has combined its St. Louis district sales office at 2015 Railway Exchange and the warehouse at Mt. Vernon, Ill., under D. M. Sutor, manager, at 2639-41 Locust Ave.,

ELECTRIC MACHINERY & MFG. CO., Minneapolis, Minn., has appointed George W. Gardner, 703 Bona Allen Bldg., Atlanta, Ga., as agent in that territory.

CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York, has opened a branch office at 1028 Sixth Ave. South, Seattle, Wash., with A. M. Andresen as manager.

DELTA-STAR ELECTRIC CO., Chicago, Ill., has appointed Robinson D. Cope and George T. Brundrett, Allen Bldg., Dallas, Tex., as sales agents in Texas and Oklahoma.

JOHNSON CORP., Three Rivers, Mich., has acquired the line of Gast air separators, aftercoolers and oil absorbers. R. O. Monroe has become manager of sales. L. D. Goff, for many years sales and factory manager for Armstrong Machine Works, is president and general manager.

BEAUMONT BIRCH CO., has appointed Ernest E. Lee Co., 115 S. Dearborn St., Chicago, as representative in that territory for coal, coke and ash-handling equipment.

R. H. BAKER CO., INC., and the Baker Supply Co., Cambridge, Mass., have been reorganized through purchase of the assets of both by Baker Engineering Corp., with R. H. Baker as president.

CHAPMAN VALVE MFG. CO., Indian Orchard, Mass., and Automatic Cone Valve Co., Mattoon, Ill., have made an agreement whereby Chapman has been given the exclusive right and license to the manufacture and sale of all products heretofore manufactured by Automatic Cone. The entire personnel of Automatic Cone Valve has been retained by Chapman Valve. David D. Goldberg, previously general manager of Automatic Cone Valve, will have direct charge of all Cone Valve sales work and engineering design at the home offices of Chapman Valve.

CHASE BRASS & COPPER CO., Waterbury, Conn., has acquired the assets of Erskine Copper Radiator Corp. The latter's business will be conducted under the newly organized Erskine radiator division of Chase. James D. Erskine, president of the Erskine company, will join Chase to take charge of sales of the Erskine division in the East.

EDGE MOOR IRON CO. has acquired the exclusive right under the Irwin patents to manufacture and distribute the Irwin automatic gas-fired boilers for all purposes. George H. Irwin has been appointed chief engineer of the newly formed Edge Moor-Irwin Gas Boiler Division of the company, with Frank S. Luney as his assistant. These boilers are best known in Illinois, northern Indiana and southern Wisconsin, where they were developed. They will be available in sizes from 50 to 1,000 sq.ft., larger on special order.

WESTPHALIA SEPARATOR CO., INC., has moved its main offices and assembly plant from 11 West 42nd St., New York, N. Y., to 30 Orange St., Bloomfield, N. J., according to an announcement by C. L. Patterson, vice-president and general manager.

CLINTON CORN SYRUP REFINING CO. has changed its name to Clinton Company and the name of its subsidiary to Clinton Sales Co., Inc.

IRVING FISHER, economist of Yale University, D. T. Lawrence, Paul H. Nystrom, Laurence H. Sloan and Frank H. Sommer have joined the advisory board of the National Industrial Advisory Corp., 22 East 40th St., New York City, a private organization engaged in assisting industry in practical operations of the Industrial Recovery Act.

FOOD MACHINERY CORP., with manufacturing plants in Lansing, Mich., San Jose, Calif., and other points, has purchased the entire assets of Peerless Pump Co. in Los Angeles and is operating it as its Peerless Pump Division. Properties involving approximately $250,000 are transferred, according to Vernon Edler, resident manager. Enlarged manufacturing facilities will be provided at the Massillon, Ohio, plant, to be operated by Peerless Pump Division. Food Machinery Corp. also owns John Bean Mfg. Co., with headquarters in San Jose, manufacturing turbine pumps and spray machines.

STRAWS

Pointing the way the business wind blows

Three engine-driven generators for the new municipal power plant in the village of Bath, Me., have been ordered from Westinghouse. The generators are directly connected to Worthington diesel engines and total 1,000 kva.

The Wm. Hamm interests, St. Paul, Minn., are arranging the details for an installation of three Skinner unaflow engines in their St. Paul office building.

Three manufacturers submitted bids for the initial installation of generators for the Boulder Dam power plant at the Reclamation Bureau offices in Denver Aug. 19. Bids covering three separate schedules were received, with General Electric low on one, Westinghouse low on a second and Allis-Chalmers low on the third.

An allotment of $1,000,000 to permit immediate construction work on the Grand Coulee Dam project on the Columbia River has been announced by Federal Administrator of Public Works Ickes. The money, which will go to the Bureau of Reclamation, Department of the Interior, is for construction of working quarters and facilities for engineers and other construction forces on the site, and erection of a bridge there across the Columbia River to enable the work to be carried on simultaneously on both sides of the river.

A group of North Carolina cities are planning to obtain Federal funds for a hydro development near Smith Mountain on the Staunton River, Va. The project has been investigated for the past seven years.

A public works loan of $250,000 to Jacksonville Produce Terminal, Inc., for a shipside terminal market and dock at Jacksonville, Fla., has been announced by Public Works Administrator Ickes. The money will be advanced upon terms satisfactory to the Administrator. The loan to the Terminal is the first application from a private corporation other than housing projects which has been approved by the Special Board for Public Works. Facilities proposed will be devoted to public use at reasonable rates. There will be precooling and cold storage facilities for fruits, vegetables and other perishable products.

Edwin Allan Binoder, manufacturing distributor of "Draftrol," a new combustion system, announces from his New York sales office, 143 Liberty St., that he has just completed installation of 93 Draftrol units in 89 stores of F. W. Woolworth Co. in the metropolitan district of New York.

Ayres, Lewis, Norris & May, consulting engineers, Ann Arbor, Mich., has been retained by the city of Adrian, Mich., to report on installation of a municipal steam or diesel power plant.

Charlottesville, Va., is considering a municipal plant to cost $62,000.

Construction of a new power plant to cost approximately $50,000 will be undertaken immediately by Westminster Paper Co., Ltd., New Westminster, B. C. The plant will generate power and also provide process steam. At present the company has a boiler house generating steam for the plant and buys its electrical energy from the central station.

Danville, Va., has asked that $2,500,000 of the public works fund be allotted for the Patrick County Pinnacles power project.

According to the *Chicago Daily Tribune*, plans are being made by The Chicago Tunnel Company for what will be the largest district heating project in the world, with capacity for heating the downtown business district of Chicago. The company has purchased a $700,000 site and contemplates a $7,000,000 plant. Chicago Tunnel Company owns and operates 62 miles of underground passageways through which coal deliveries and ash removals for buildings in the Loop area are made, and under present plans steam at 400 lb. pressure will be conveyed through them in 24-in. mains. It is estimated that nearly a billion and a half cubic feet of building volume will be made accessible to steam mains through these tunnels. Coal consumption for an average winter day will reach 1,200 tons. It is understood that the work will be undertaken as soon as negotiations for financing are completed.

St. Peter, Minn., is planning a municipal power plant to cost $225,000 with equipment.

Radford, Va., has secured Federal permission for its municipal hydro plant on Little River. A fund of $129,000 is being arranged.

United States Engineer Office, Huntington, W. Va., has just received bids for construction of power house and locks, etc., on Kanawha River, near Winfield, W. Va.

Among cities considering municipal plants are Bessemer, Ala., Atlanta, Ga.; Knoxville, Tenn., Winchester, Va.; Cushing, Okla.; Hominy, Okla.; Cincinnati, Ohio; Oklahoma City, Okla.; Warsaw, Ind.; Oakland, Calif. Chester, Ill., has retained W. A. Fuller Co., St. Louis, Mo., as consulting engineer to make preliminary surveys for a plant to cost about $150,000. Harrisburg, Ill., is planning to issue $460,000 worth of bonds and has engaged Russell & Axon, St. Louis, as consultants.

The Federal Power Commission has authorized a permit for the Grand Coulee hydro-electric project on the Columbia River, Wash. Field work has been started.

Felt Products Mfg. Co., Chicago, Ill., is adding to its plant as the result of an increase in business.

Pilsner Brewing Co., Seattle, Wash., is planning a plant at Portland, Ore., to include a power house, to cost $300,000.

Alexandria, Minn., has just asked bids for turbine-generator and complete auxiliary equipment for a city-owned power plant.

An additional 42,000-hp. generating unit has been placed in operation at Safe Harbor hydro plant on the Susquehanna River, Pa. This is the fifth unit to be placed in service, which brings installed capacity up to 212,500 hp.

Bordentown, N. J., has secured estimates of cost from committee recently appointed, headed by Charles B. Rodgers, for a municipal electric light and power plant, totaling $135,000, with equipment. Favorable action is scheduled soon.

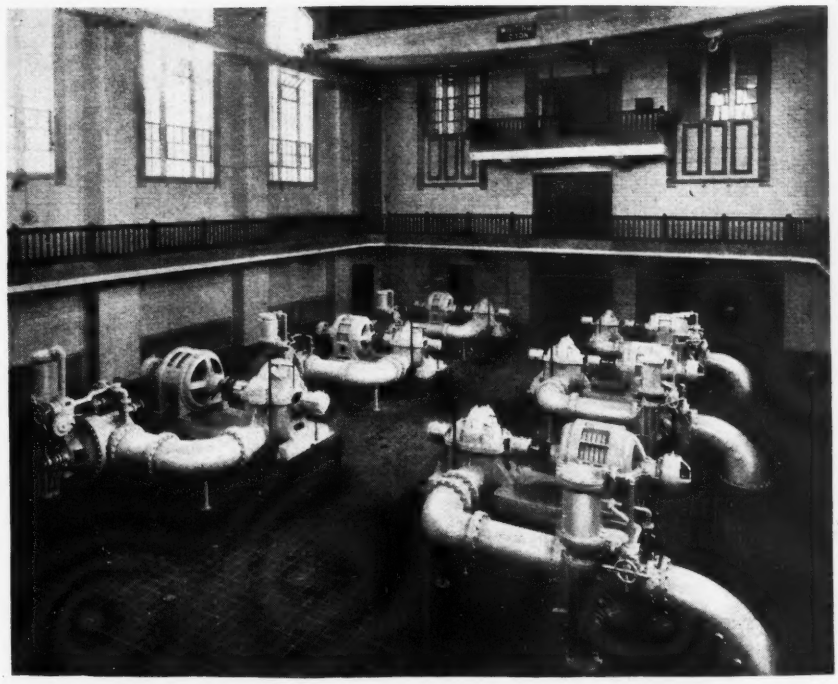
The Naval Academy, Annapolis, Md., will extend and improve its power plant, an appropriation of $575,000 having been authorized.

Electric motors and control apparatus amounting to about $60,000 have been ordered from Westinghouse by Detroit Edison for improvements now being made in the Connors Creek Power House. Included are two 700-hp. and two 400-hp. fan motors, two 500-hp. boiler feed pump motors, and ten motors ranging from one to 60 hp. for auxiliary equipment.

Appropriation of $150,000 has been authorized for extensions and improvement in power plant at Mare Island, Calif., Navy Yard. Appropriation also made for improvements and extensions in power plant at Washington, D. C., Navy Yard, to cost $325,000.

Several municipalities in Ohio are arranging plans for power plant developments. Kenton is having plans drawn for a new steam-electric power plant to cost about $430,000; H. P. Jones, Second National Bank Bldg., Toledo, is consulting engineer and William P. Ladkin, Springfield, Ohio, electrical engineer. Dover plans addition of new 2,000-kw. steam-turbine-generator unit with auxiliary equipment, estimated to cost $100,000; Waldo Hartline is engineer in charge. Amherst has concluded arrangements for new power plant using oil-burning engine units, estimated to cost $100,000; F. N. Straus, 2613 Queenstown Road, Cleveland, is engineer. Canton has appointed a commitee to secure details and estimates of cost for new electric light and power plant, and distributing system, preliminary figures placing cost at close to $7,000,000.

Cleveland is concluding details for vote of citizens at November general election on bond issue of $2,000,000, for expansion and improvements in municipal power plant, with installation of considerable new equipment. Mogadore has preliminary plans under way for a city-owned electric light and power plant, and will soon secure estimates of cost. Bellefontaine has approved plans for a new addition to present lighting plant and will install additional equipment. Edgerton has authorized plans for a new municipal lighting plant; George Champe & Associates, Toledo, are consulting engineers. Columbus proposes an expansion and improvement program at municipal power station to cost about $900,000, including installation of a new 10,000-kw. generator unit and auxiliaries; proposition will be placed before voters at general November election. Circleville has authorized surveys and estimates of cost for a new municipal electric light and water plant; Fosdick & Hilmer, Union Trust Bldg., Cincinnati, are consulting engineers.



Fort Wayne Builds New Filtration Plant

Three Rivers filtration plant of the City of Fort Wayne, Ind., is located at the convergence of the St. Mary and St. Joseph Rivers to form the Maumee. Its filtering capacity is 24 m.g.d., raw water being brought from the St. Joseph 3½ mi. above in a 42-in. steel main. An emergency inlet is also provided, admitting water from directly in front of the plant. Nine Byron Jackson pumps are installed. The six high-service units operate at 175-ft. head and all but the sixth at 1,200 r.p.m. (sixth is 900). They develop 4,200; 5,600; 7,000; 8,400; 8,400; and 10,500 g.p.m. capacity. All are driven by 2,300-volt, 3 phase, 60-cycle, GE synchronous motors. The two plant-service pumps operate at 40-ft. head and provide 10,000 and 14,000 g.p.m. They are driven by 2,300-volt, GE, vertical, induction motors. The 2,100-g.p.m. wash-water pump (65-ft. head and 1,750 r.p.m.) is driven by a 440-volt, GE, motor.

H. Tollemache & Company, Ltd., of Canada House, London, are about to produce pulverized coal at a Yorkshire mine. The pulverized coal will be distributed to consumers in specially designed tank trucks, from which it will be discharged by hose connection into the consumers' tank.

Department of Mental Diseases, Commonwealth of Massachusetts, Boston, is planning construction of power plants for central steam heating service at a number of state institutions. A new plant is proposed at Northampton State Hospital to cost over $85,000, with equipment, and for which plans will be drawn by Edward C. Brown Co., 77 Summer St., Boston, consulting engineer; improvements and extensions will be made at present power house at the Medfield State Hospital, including installation of new boiler equipment; expansion and improvements will be carried on at power house at State Hospital at Grafton, including installation of new equipment, estimated to cost about $110,000; Charles T. Main, Inc., 201 Devonshire St., Boston, is consulting engineer for latter project; plans are in progress for a new electric distribution system at the State Colony at Gardner, to cost about $25,000, for which A. B. Franklin, Inc., 38 Chauncy St., Boston, is consulting engineer; a new steam power house is proposed at the Boston State Hospital at Dorchester, reported to cost over $100,000, with equipment, and for which plans will be drawn by the R. D. Kimball Co., 6 Beacon St., Boston, consulting engineer.

Bellingham, Wash., city council has voted to prepare an ordinance authorizing submission of a proposal to voters at the next municipal election for the issuance of $100,000 in general obligation bonds for light and power development on Lake Whatcom and Whatcom Creek.

Springfield, Ill., has plans for extensions and improvements in municipal waterworks to cost $1,385,000, and a Federal loan in that amount has been secured. Work will include installation of a large electric-operated pumping plant and water purification works, as well as pipe lines and auxiliary equipment. Program will be started at early date.

A group of ten municipalities in the Black Hills district, S. D., propose to construct and operate an electric generating plant for joint commercial service. Station will be steam-operated and in the coal-field area at Gillette, Wyo. It is estimated to cost about $2,000,000, with transmission lines to the different communities and power substations for local distribution, distributing lines, etc. Mayors and town officials held a meeting recently at Spearfish, S. D., and appointed the following committee to secure details of program, with equipment data and estimates of cost: C. E. Dawson, Lead, S. D.; M. Schechberger, Rapid City, S. D.; and Wayne George, Spearfish.

Somers Mining Co., Cadiz, Ohio, W. F. Hazen, superintendent, is planning construction of power plant for coal mine service, known as Somers Mine, estimated to cost about $75,000, with equipment.

Balatou Mining Co., 1107 Hobart Ave., San Francisco, Calif., has purchased two 600-hp. diesel engines for use in its Philippine mines. They will operate at a 3,000-ft. elevation. Due to difficulties of shipping to the isolated spot where they will be installed, the frames had to be split. An order for a third unit has just been received.

THE COVER

• FROM coast to coast and border to border, new power plants are rising to increase the steam- and power-generating capacity of the Nation. The cover illustrates six new examples. They may be identified as follows:

1 Diablo Dam, near Skagit, Wash. Initial capacity to be 166,000 hp., ultimate 320,000. Two 83,000-hp. francis units to operate at 171.4 r.p.m. and 327-247 ft. head. Project of the City of Seattle, now awaiting Federal aid.

2 Vernon, Calif., municipal diesel plant, largest in this country. Five 7,000-hp. engines installed; began operation in July. All are 2-cycle double-acting, solid-injection 8-cyl. units, 24x26 in., operating at 167 r.p.m.

3 Duluth, Minn., central heating plant has four 90,000-lb.-per-hr. boilers. Took load last season for the first time. Story on page 514, this number.

4 Hamilton Dam, on the Colorado River near Burnet, Texas. This is the first and largest of three in a power project there. Two 15,000-hp. francis-type turbines are being installed, with provision for a third. They will run at 171.4 r.p.m. under a head ranging from 65 to 126 ft.

5 Lamoka Power Corp. natural-gas-engine power plant on Lake Keuka, N. Y., operated in parallel with a pumped-storage hydro-electric project. In the foreground are three 12-cyl. vertical gas engines, 1,800 hp. each, while in the background is a 6-cyl., 1,200-hp. unit. Story in *Power* for August, 1932.

6 Buzzard Point Station of Potomac Electric Power Corp., only central station to be installed this year. Two 375,000-lb.-per-hr. boilers and the first of two 35,000-kw. generators will take load late this month. Story on page 505, this number.

New Bulletins

Air Compressors — Allis Chalmers Mfg. Co., Milwaukee, Wis. Four-page leaflet 2159; single-stage, rotary air compressors and vacuum pumps; range of volumes from 50 to 2,000 c.f.m., pressures up to 150 lb. and vacuums up to 29.85 in. mercury.

Air-Conditioning — DeLaVergne Engine Co., sales agent for Baldwin-Southwark Corp., Philadelphia, Pa. Twelve-page bulletin No. 48; DeLaVergne air-conditioner, gives specifications.

Air-Conditioning—American Blower Corp., Detroit, Mich. Eight-page bulletin No. 2927; on Ross "Decalorator" described recently in *Power*.

Air-Conditioning—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Sixteen-page bulletin "Air-Conditioning for Health, Comfort and Profit"; non-technical description.

Compressed Air Equipment—Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Four-page bulletin YB-2001; Yarway-Becker automatic control valve for compressed air lines.

Diesel Engines—Superior Engine Co., Springfield, Ohio. Six-page bulletin No. 129; stationary diesels of two sizes, 50 to 180 hp., and 80 to 350 hp.

Diesel Engines—Caterpillar Tractor Co., Peoria, Ill. Eight-page bulletin on "Caterpillar Diesel Power Units," and fourteen-page bulletin on "Caterpillar Gasoline Power Units," specifications and applications.

General Electric—General Electric Co., Schenectady, N. Y. Four-page, GEA-1761 on CR1061 motor-starting switches for fractional-horsepower motors. Four-page bulletin CR7505-K1; photoelectric relay application. Two-page folder GEA-1746 on Glyptal-cloth insulated cable. Four-page GEA-1765; G-E fractional-horsepower gear-motors, ¼ to ¾ hp. Two-page GEA-1771; Automatic timer, telechon-motor-operated, for use on a.c. circuits. Four-page GEA-1695; G.E. quiet squirrel-cage and wound-rotor motors. Two-page GEA-1714; G.E. sound-isolating motor bases.

Evaporators—York Ice Machinery Co., York, Pa. Two bulletins; York spiro-fin evaporators and York square-fin evaporators.

Piping—Crane Co., 836 S. Michigan Ave., Chicago, Ill. Two bulletins, "Born of Retrenchment," saving by modernization of equipment and losses resulting from failure to modernize; and "After 3 Years of Starvation Maintenance," practical ways to cut costs by modernization.

Power Transmission—Link-Belt Co., 300 W. Pershing Road, Chicago, Ill. 48-page book, Link-Belt exhibit at a Century of Progress, Chicago; applications of Link-Belt equipment, lists plants and agencies.

Refrigerating Equipment—Societe de Condensation et d'Applications Mecaniques, 42 Rue de Clichy, Paris 9e, France. Extensively illustrated publication "Le froid en brasserie" vacuum refrigeration equipment.

Solenoid-Operated Valves—W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa. Four-page bulletin 633; solenoid-operated valves for air, steam, water, oil, ammonia, gas.

Sulphur Determination—Bausch & Lomb Optical Co., Rochester, N. Y. Six-page bulletin on scopometry; improved Exton Junior Scopometer which can be used for turbidimetric determination of sulphur in coal, boiler water, and turbidity in water.

Water-Level Indicator—Dewrance & Co., 165 Great Dover St., London, S.E. 1, England. Eight-page pamphlet; bi-color water-level indicator; specifications and installations.

Water Heaters—Bell & Gossett Co., 3000 Wallace St., Chicago, Ill. Four-page bulletin on Unitem submerged water heaters for apartments, hotels, stores and office buildings.

Water-Power Equipment—Newport News Shipbuilding & Dry Dock Co., Newport News, Va. 61-page catalog describes 30 or more projects in which company's water-power equipment is installed. Includes description of hydraulic laboratory.

Welding—Linde Air Products Co., 30 E. 42nd St., New York, N. Y. Sixteen-page illustrated bulletin "Oxwelding for General Maintenance," oxy-acetylene process of welding and cutting in reclamation of broken and worn machine parts, and installation of equipment.

Welding Stainless—Republic Steel Corp., Central Alloy Division, Massillon, Ohio. 17-page booklet, "The Welding of Enduro Stainless Alloys," gives complete data.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Eureka—City plans developing water and power project on Mad River, est. $1,200,000 and $375,000 respectively. C. C. Kennedy, Call Bldg., San Francisco, engr.

Calif., Lodi — City plans municipal power plant on Mokelumne River.

D. C., Wash.—District Comrs., District Bldg., soon takes bids new pump at Anacostia Pumping Station, $15,000.

Ill., Alton—City Council approved appointment of special commission to study feasibility of public ownership of local electric light, power, gas and waterworks plants. Informal estimates about $1,200,000 for city to construct its own plants.

Ill., Chester—City retained W. A. Fuller Co., consult. engrs., 2916 Shenandoah Ave., St. Louis, Mo., to conduct preliminary surveys in connection with contemplated construction of municipal light and power plant and distribution system. $150,000. Will ask loan under National Industrial Recovery Act.

Kan., Anthony — City made application for loan under terms National Industrial Recovery Act to finance construction power plant. $60,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., engrs.

La., Crowley—City, N. M. Chambers, mayor, plans application for loan from Govt. for new municipal light plant. M. Bernard, Crowley, city engr.

Mich., Detroit—Commercial Malt Co., A. R. Moore, pres., 1432 Lafayette Bldg., making plans 1 million bushel malt plant and equipment to include malt house, dry kiln, power plant, office building and battery of 6 grain elevators with 500,000 bu. capacity of grain, Dix-Vernor Hy. $500,000. Galland-Henning Mfg. Co., 229 East Wisconsin Ave., Milwaukee, Wis., engrs.

Mich., Detroit—Goebel Brewing Co., Rivard and Maple Sts., plans by Harley & Ellington, archts. and engrs., 1507 Stroh Bldg., 2 story, basement, brick, steel, rein.-con., plain found., power plant to have concrete or brick stack, two 20 hp. boilers, coal-fired to drive 2 ammonia compressors, 1 electric motor drive for 3rd compressor unit, coal handling equipment, incl. stokers, etc. $50,000.

Mich., Dowagiac—City making plans municipal electric light plant. $200,000. C. Voorhees, city engr. Plans to petition for Federal aid under National Industrial Recovery Act for financing project.

Mich., Hamtramck—City Council plans application for loan under terms National Industrial Recovery Act for municipal electric power and lighting plant. $750,000. G. Jerome, 1850 1st Natl. Bank Bldg., Detroit, city engr.

Mich., Harrison—Village, survey, plans and estimates to be prepared for municipal electric lighting and power plant, incl. steam driven generating equipment. $75,000. Francis Eng. Co., 204 Eddy Bldg., Saginaw, engrs. Petition to be filed for Federal aid in financing under N.R.A.

Mich., Owosso—City filed application with State Administrative Bd. for financing under National Industrial Recovery Act construction sewage disposal plant, incl. primary and secondary treatment Imhoff tanks, with spray filters, pump house with motor driven pump with 18 ft. lift. $131,440. Pate, Hamann & Hirn, consult. engrs., 1610 Washington Blvd., Detroit, completed plans.

Minn., Hancock—Voted $40,000 constructing municipal light and power plant. H. I. Frisbee, Hancock, constr. engr.

Minn., St. James—Election Oct. 10 on question of constructing municipal electric light and power plant and on issuing certificates of indebtedness to finance. $60,000. Will ask loan under National Industrial Recovery Act if carried.

Minn., St. Paul—Hamm Brewing Co., E. L. Nippolt, vice pres., 681 East Minnehaha St., plans 50x190 ft. 2,000 hp. brick, steel power plant, 681 East Minnehaha St. C. H. Johnston, 715, 360 Robert St., archt.

Mo., Moberly—City plans municipal power plant and distribution system. Filed application for $700,000 loan under National Industrial Recovery Act.

N. H., Portsmouth—Yards & Docks, Navy Dpt., Wash., D. C., plans improving power plant at Portsmouth Navy Yard. $100,000 appropriation granted.

O., Alger—Village Council making plans 100,000 gal. elevated tank, mains, fire hydrants, deep well and pumping plant, automatic control complete, 125 g.p.m. deep well pump, etc. $38,639. Made application to Federal Emergency Administration for loan. E. Ellis, 1158 Hazel Ave., Lima, engr.

O., Alliance—Municipality, plans light plant, $700,000. Petition circulation has been completed and turned over to Mayor Westover. Project will be financed by bond issue going to vote of people at November election.

O., Baltimore — Village making plans new water system, wells, pumping station, elevated storage tank. $35,000. N.R.A. project. Jennings-Lawrence Co., 12 North 3rd St., Columbus, engrs.

O., Basil—Village making plans new water supply, elevated storage tank, pumping station. $35,000. N.R.A. project. Jennings-Lawrence Co., 12 North 3rd St., Columbus, engrs.

O., Columbus—Preliminary plans have been completed for large addition to Columbus Municipal Light Plant, incl. 1 story, 90x150 ft. brick, concrete addition to east of plant, two 1,500 hp. boilers and one 10,000 kw. turbine and all auxiliary equipment neecssary, incl. feed pumps, stokers, switching equipment, circulating pumps, condensers, etc. $971,000. After H. C. Worley, mayor, examines plans they will be turned over to City Council with request that bond issue election on November ballot be provided by proper legislaiton. Council and Mayor are also studying possibility of obtaining Federal aid for project under National Industrial Recovery Act.

O., East Liverpool—P. F. Loftus, engr., Oliver Bldg., Pittsburgh, Pa., submitted report to city on construction of municipal electric power plant distribution and street lighting system. Election Nov. 7 to vote on $1,250,000.

O., Elida—Village Council making plans 100,000 gal. elevated tank, 18,128 ft. 6 in. c.i. Class C mains, fire hydrants, 125 g.p.m. deep well turbine, electrically operated automatic control complete. $32,696. Made application to Federal Emergency Administration (subject to approval of administrator) for loan. E. Ellis, 1158 Hazel Ave., Lima, engr.

O., Gahanna — Making plans water supply, incl. pumping station, distribution, elevated storage tank. $33,000. Jennings-Lawrence Co., 12 North 3rd St., Columbus, engrs. N.R.A. project.

O., Harrod—Village making plans laying 14,436 ft. 6 in c.i. mains, constructing elevated tank, pumping plant, automatic control, fire hydrants, 125 g.p.m. deep well pump, electrically operated with standby of gas engine, 1 brick building. $26,394. N.R.A. project. E. Ellis, 1158 Hazel Ave., Lima, engr.

O., Hebron—Village making plans new water supply, elevated tank, distribution system and pumping station. $35,000. N.R.A. project. Jennings-Lawrence Co., 12 North 3rd St., Columbus, engrs.

O., Jackson Center—Council making plans 100,000 gal. elevated tank, mains, fire hydrants, deep well, pumping plant and automatic control, complete, 125 g.p.m. deep well turbine, electrically operated-gas engine standby. $37,620. Made application for loan from Federal Emergency Administration to finance. E. Ellis, 1158 Hazel Ave., Lima, engr.

Okla., Hollis—City sketches made municipal electric light plant. $100,000.

Okla., Woodward—City made sketches municipal electric light plant. $100,000.

Pa., Blairsville—Boro, T. C. North, mgr., instructed to obtain complete data on construction cost of electric light and power plant and cost of maintaining same for borough.

S. C., Clinton—City, H. Y. Abrams, mayor, making application for funds through State Advisory Bd., P. Wks., Administration Bd., Capt. J. L. M. Irby, Columbia, engr., to finance construction municipal electric plant $100,000, and municipal building $60,000.

Texas—U. S. Eng., Wash., D. C., plans flood protection and reclaiming 1,000,000 acres land. 60 000 hp. hydro-electric plant, etc., for Brazos River Reclamation and Conservation Dist. $50,000,000. State planning appropriation of $350,000 for surveys, etc.

Tex., Marfa—City, c/o Mayor, plans power plant. $100,000.

Tex., Pecos—City, c/o Mayor, plans water system and light plant $250,000. Application for loan made under terms National Recovery Act.

Tex., Tom Ball—City plans city hall, electric power and lighting plant and municipal ice plant. $110,000. Made application for loan under terms National Industrial Recovery Act.

Wash., Spokane—City Council approved constructing dam and power plant at Upriver Station, $612,820; maintenance building $24,887; south side pumping station and mains $276,984; cover for 9th Ave. reservoir, $148,773; cover for 23rd St. tower $5,790; drain for North Hill Reservoir, $3,857. Total $1,073,114. Application made to federal government for 30% and 20% to state, and proposed bond issue with water revenue 50%.

B. C., Nelson—Christian Community of Universal Brotherhood plans power plant. $30,000.

Que., Sherbrooke—Shawinigan Water & Power Co. Ltd., J. C. Smith, mgr., soon takes bids water and power development work at Rapid Blanc, incl. initial installation of 80,000 hp. equipment.